NOTES

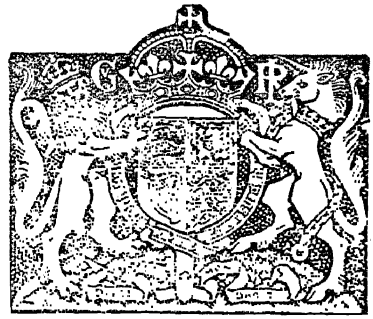
ON THE

VEGETABLE OIL INDUSTRY

IN INDIA (1931)

BY

J. A. HARE DUKE



ALLAHABAD :

THE SUPERINTENDENT, PRINTING AND STATIONERY, UNITED PROVINCES

1931

Notes on the Vegetable Oil Industry in India, 1931, by J. A. H. Duke.

(1) Vegetable oil industry and its potentialities.

The industry of extracting oil from the seeds of various plants has been common to India as to most countries for generations. Definite data is not available of the industry in India from the early days, yet we find in 1931 that the bulk of the seed crushed in the country is still effected by somewhat primitive methods.

The indigenous Indian oil milling machinery is very near akin to the mortarium of the Romans and to the stone pestle and mortar mill which was used in Pompeii 2,300 years ago.

The vegetable oil industry in all countries is of the greatest importance, since it is a key industry without which a number of other industries could not be carried on. During recent years the importance of the industry has become very marked, since the world's consumption of vegetable oils has steadily increased, and whereas formerly Western peoples depended almost entirely on animal fats for edible and soap making purposes these trades have in 25 years assumed such immense proportions that the former supplies of raw material have been found insufficient. To this fact alone does the vegetable oil industry in almost all countries owe its present status.

India is perhaps an exception, since she has always been a large consumer of vegetable oils as food, consequently her oil industry was probably in a far higher state of development 200 years ago than that of most other countries.

The advent of the steam engine and the Hydraulic press altered this position. The export trade in oil which India had enjoyed in former days died away, and instead of oil being exported, oil seeds were exported, and Europe started to send oil to India.

Since the days when India had an important lead in the oil crushing industry many large organized industries have sprung up in India.

The mills, factories and manufacturing concerns making such things as steel, jute, woollen and cotton goods, leather, sugar and flour have all been equipped with modern machinery, and the mills have been, to a great extent, staffed with highly paid specialists, engineers and mechanics. Comparison between such industries and their methods and the vegetable oil industry of India shows that there is a very marked contrast.

On the one hand, there have been built up in the new industries enormous mills and factories with most up-to-date appliances and methods. On the other we see the old established oil industry carried on upon lines very similar to those of generations ago, and taking but little advantage from up-to-date methods and machinery.

(*a*) THE IMPORTANCE TO THE OIL INDUSTRY OF PROGRESSIVE AND SUCCESSFUL AGRICULTURE.

Agriculture, the basis of most industries, requires to be successful and thriving before industries can develop on prosperous lines. The vegetable oil industry is very closely allied to agriculture, since the Indian agriculturalist supplies the raw material. The oil industry looks to agriculture, with its population of 224 millions, to buy the oil which is produced and to feed the oil cake to some 51½ million milking cows and buffaloes.

Indian agriculture produces very large quantities of oil seeds, but with improved agricultural methods put into use with intelligence there could be vastly greater quantities of oil seeds produced of infinitely superior quality which would go far towards developing and extending India's oil crushing industry. To effect the greatest possible improvement there is needed research work, large experimental farms and agricultural colleges. Improvement entails having to use wood or coal as fuel, and also some discomfort during the period of changing conditions so as to use cowdung entirely for manure. When this has been recognized by the Indian people as being important to the country's welfare, and they are prepared to make the change, then and then only will there be prosperous agriculture, a prosperous oil industry and many others in addition.

Upon the quality of the seeds produced and delivered to the oil mills depend very largely their prosperity, and it would be well if the attention of agricultural community could be drawn to the losses which they cause to India each year by careless methods.

(*b*) THE MARKETING OF UNCLEANED SEED.

Oil seeds and other food grains as delivered to buyers by the Indian agriculturist contain large amounts of dirt, sand, kankar and straw which is present amongst the seed in quantities varying between 5 and 17 per cent.

This, while reacting upon the agriculturalist who receives a correspondingly lower price for his seed, causes very considerable loss to the oil miller in freight, loss of oil and unnecessarily heavy wear on machinery.

Exporters of seed have erected large and costly seed cleaning and separating plant in order to bring the seed into a marketable condition. The cost and upkeep of these establishments is duly adjusted in the price which exporters pay for seed. If an average figure be taken of the amount of foreign material which is annually transported with India's oil seed crop from the grower to the oil miller or exporter, it will be found that some 500,000 tons of rubbish are being taken about the country, necessitating innumerable bullocks and men wasting their energy, causing congestion on the railways by utilizing railway wagons, wasting coal and labour in transporting material which could profitably be utilized in manure pits.

Seed containing an average of 5 per cent. of non-oleaginous material causes annually to Indian oil mills in loss of oil alone approximately ¾ crore of rupees. The wear and tear on the plant, which is a very large sum, must be added to this figure.

The agriculturalist would do well to remember that the bulk of this rubbish is returned to him in the oil cake which he may purchase at varying prices from Rs. 2-8-0 to Rs. 4 per maund, which material again damages his own interests by imparing the digestive organs of his cows and buffaloes, for but few oil mills in India are equipped with seed cleaning machinery.

(*c*) India's trade in oil seeds.

The oil seeds of India may be divided into four classes and are valued at Rs. 80 crores.

(i) Pure field crops of cultivated seed.

(ii) Mixed field crops of cultivated seed.

(iii) Seeds from trees not specially cultivated.

(iv) Seeds from field cultivated crops where seed is treated as a bye-product.

(*i*) *Pure field crops of cultivaied seed or plantations.*

Seed.	*Acreage.*
Linseed ..	2,621,000
Groundnuts	5,400,000
*Rape and mustard	6,000,000
Sesame or til	4,331,000
Hemp seed ..	
Niger seed ..	
Copra ..	800,000
	19,152,000

In addition there are considerable tracts of land cultivated and growing such seeds as Niger and Safflower seed.

(*ii*) *Mixed field crops of cultivated seed.*

Seed.	*Acreage.*
Linseed ..	737,000
Sesame or til	675,000
Rape and mustard	
	1,412,000

(*iii*) *Seed from trees.*

There are no definite figures for the amount available each year. The trees are grown in the forests, on canal banks and roadsides, as well as being scattered over uncultivated lands in various parts of

*There are no definite figures for the mixed crops of rape and mustard.

India. Those which are used commercially must amount to approximately 700,000 tons and include the following :—

Vernacular name.	*Botanical name.*
Mahua	Bassia Latifolia.
Illippe	Bassia Longifolia.
Phulwara	Bassia Butyracca.
Dhupa	Vateria Indica.
Kokum, mangosteen ..	Garcinia Indica.
Vegetable tallow ..	Sapium Sebigerum.
Chaulmoogra	Hydnocarpus Kurzii.
Maroti	Hydnocarpus Wightiana.
Kusum or Macassar ..	Schleicheria Trijuga.
Kaiphal	Myristica Malabarica.
Margosa or Neem ..	Melia Azedirachta.
Pongam, Karunga or Hongay	Pongamia Glabra.
Ben	Moringa Pterygosperma.
Laurel or Domba or Punna ..	Caloppyllum Inophyllum.
Croton	Croton Tiglium.
Luffa	Luffa Aegyptiaga.
Kapok	Bombax Malabaricum.
Akhrot or Walnut .	Juglaus Regia.
Gynocardia .. .	Gynocardia Odorata.
Candle nut .. .	Aleurites Moluccana.
Kakhan	Salvadora Oleoides.
Cashew nut	Anacardium Occidentala.
Gamboge	Garcinia Pictoria. Garcinia Morella.

(*iv*) *Seed from field crops where the seed is treated as a bye-product.*

	Acreage.
Cotton seed	15,687,000
Tea seed	..
Poppy seed	..

The cotton seed crop amounts to figures between 1,500,000 and 2 million tons. The acreage of niger seed, tea seed and poppy seed is not available.

Statistics relating to area and yield of oil seeds in each province will be found in Appendix I.

Table showing the seed required for sowing, for export, for cattle food and what is available in India for the oil crushing industry are in Appendix II.

Import of oil seeds, Appendix III.

Details of oil seed exports, Appendix IV.

There are no statistics relating to the amount of seed available from such tree crops as Mahua, Dhupa, Illippe, Stillingia Sebifera, Neem, Karuanga and others which if taken into account would probably amount to almost one million tons.

(*d*) THE OIL MILLS AND THEIR WORK.

The oil mills of India are numerous ; they vary considerably in size and equipment.

Taken as a whole they at present compare very unfavourably with the mills of Europe and America so far as efficiency and methods are concerned.

There are crushed in India approximately 3,700,000 tons of oil seeds from which the average yield of oil does not exceed 33 per cent. Thus the oil produced is approximately 1,220,000 tons, of which some 5,300 tons are exported of a value of Rs. 29,36,840, leaving in India 1,215,700 tons of oil of an approximate value of Rs. 42,59,38,000, to which may be added the imports of 4,000 tons of oil worth Rs. 2,06,00,000.

These figures, although of considerable magnitude, do not mean that the oils at present produced or imported are sufficient for the needs of the people, but since the population are unable to pay for more, they have to go on short rations. The oils produced and imported are used for food, soap manufacture, paint and varnish manufacture, lubrication and other manufacturing purposes. The oil at present available in India with that imported represent annual ration of less than 10 lbs. per person, to cover all requirements under the above headings.

(*e*) Oil cake.

The oil mills in India produce annually approximately 2,442,000 tons of oil cake, of which 2,037,000 tons valued at Rs. 12,61,00,000 are retained and consumed in the country, while 3,75,000 tons are exported. These exports are valued at a total of Rs. 3,84,17,949, details of which are given in Appendix VI.

Indian agriculturalists possess some 38¼ million milch cows and 13¼ million female adult buffaloes, besides innumerable female adult goats, upon which India depends for her supplies of milk and ghi.

Since the amount of oil cake left in the country of a kind fit for the feeding of cattle represents only 6 ounces of cake per day for the milk producing cows and buffaloes without any allowance for goats, it would appear that India cannot afford to export any oil cake. This export of oil cake, coupled with wasteful methods in Indian agriculture, are very largely responsible for the import to India of refined vegetable oils, to be used as substitutes for ghee, to the value of two crores of rupees per annum.

(*f*) The oil miller's equipment.

The oil millers of India may be divided into four classes:—

The first of these are by far the most numerous and crush the bulk of the seed. This class is composed of small village teli, whose mill is in his house and whose equipment consists of a wooden pestle and mortar, modelled on the lines of that used in Pompeii 2,300 years ago. The Pompeii mill was, however, infinitely more durable, being made of stone.

The pestle of the Indian mill is driven by one or a pair of small bullocks depending upon the size of the mortar. Of these small mills there are probably 8,000 to 10,000 in each province. The efficiency of these machines is of a very low order, the output being

small and cost of upkeep high. These facts coupled with lack of capital do not permit the teli to make much profit; in fact, if he were to keep a cost account and charge up the cost of labour supplied by himself and family at current rates, he would invariably find that his mill was unprofitable.

In the second class are a larger type of mill equipped with ghannis or kolhus, somewhat similar to those used by the small teli, but driven by steam, oil engines, and in some of the larger towns by electric power. Efficiency in these mills is even lower than that attained by the village teli. The oil extracted, ranges between 30 and 33 per cent., although the seed may contain 45 to 50 per cent. Such mills vary in size from 5 pairs of ghannis up to 150 pairs. Such machines costing Rs. 350 per pair consume 1 to 1½ H.P. to drive them and crush only 13 lbs. of seed each per hour, while the annual cost of repair, upkeep and depreciation ranges between 50 and 80 per cent. depending upon whether the mills work by night as well as by day. This class of mill is gradually changing over to modern methods, and many have already joined the ranks of the third class.

The third class of oil millers are those who have either added modern plant or have at some time discarded the ghanni entirely and have installed hydraulic presses. These are mostly of the Anglo-American type of press, which in the past in Europe have been usually installed where the product to be manufactured was oil cake and the bye-product was oil. Such presses, while being suitable for most of the Indian oil seeds, cannot be considered entirely suitable for all classes, nor can they be considered suitable for Indian conditions and labour.

Into the final class fall those mills to which have been added oil expellers, or which have been recently started equipped entirely with oil expellers.

During the past 8 years there have been many new oil mills started in India, or existing mills have added these most efficient machines to their equipment.

In this comparative short period no less than 574 oil expellers have been erected in India, of which 210 are in Bombay Presidency, 92 in Madras, 69 in the Punjab, 50 in United Provinces, 44 in Bengal, 35 in Central Provinces, the balance being in Bihar and Orissa and various Indian States.

This modernising of plant is a move in the right direction, but it is to be feared that the Indian mill owner will find modern plant and its upkeep quite as expensive as the indigenous machinery, unless the mills are also equipped with efficient seed cleaning and milling plant of a sufficiently large and efficient type. Even though this equipment may be added, it will be found expensive to run, unless the plant is in the care of efficient engineers, mechanics and workmen.

Here possibly lies the greatest stumbling block in the way of advancement for the Indian oil industry, particularly as the proprietors and managers are men with little mechanical knowledge.

Both of these classes are unfortunately unaccustomed to pay their so-called engineer more than Rs. 50 to Rs. 100 per month.

In the oil crushing industry there is a marked absence of skilled engineers and mechanics, as may be judged by the fact that makers of oil mill machinery supply three times more spare parts per machine to India than are supplied to other countries.

(*g*) Oil mill methods.

Throughout the oil milling industry there is enormous waste of seed, oil, oil cake, labour and fuel. The rate of depreciation of plant is also much above that of other countries.

The wastage in oleaginous material can be estimated at Rs. 90 lakhs annually, to which can be added a large sum for waste of fuel, labour and depreciation, all of which are caused by ignorance and bad supervision. The lack of engineering and technical knowledge in the industry very largely accounts for mills being equipped with the wrong type of plant for the work which is undertaken, and unless this deficiency is rectified and mill owners are prepared to spend money in equipping their mills on proper lines, there cannot be any great improvement in efficiency or prevention of waste. There is a noticeable lack of knowledge throughout the industry on matters relating to the trade, both in and outside India Very few mills are capable of manufacturing any products other than crude oils and oil cake.

(*h*) The future outlook.

In an agricultural country with a population of 320 millions, all of whom are potential consumers of oil, buyers of oil cake and possible users of soap, paint, varnish, who consume large quantities of oil in confectionery, and who to some extent use vegetable oil for burning purposes, it may be that the oil industry has a very bright future.

Perhaps the greatest of oil delusions connected with the oil industry in India is the fact that, although there are 320 million people, very few of them have money to buy oil, oil cake or soap, and of those who can buy only a few have the knowledge of how to use their purchases to the best advantage.

Even those people whose livelihood depends alone on the production of oil from oil seeds are wasting immense quantities of it by spilling it about their mills, godowns and mill compounds.

The future speed of development of the industry to a great extent depends upon agricultural development, since this and other industries must have buyers of their manufactured products; and if the agriculturalist is in poverty, the effect is instantaneous on industry. Indian agriculture requires vast quantities of manure and water to enable it to be raised to a prosperous condition, and when there is the first sign of a general awakening from the present apathy, it will very rapidly react upon the fortunes of the oil industry as well as others.

(*i*) Capital and co-operation.

Europe and America have built up their oil industries by the hard work of people knowing their business; such people have not been afraid of paying high rates of remuneration to persons who worked and had intelligence.

The working capital for these industries has been found almost entirely by co-operation, that is by the co-operation of small and large capitalists who were prepared to risk their savings by taking up shares in joint stock companies. Businesses such as these had responsible directors, some of whom at least were technical men with a long experience in the industry.

The industries started on sound lines progressed in the hands of men with technical and financial ability, equipped with machinery of the most up-to-date type placed in the hands of skilled engineers and mechanics. The concerns were backed by ample capital for working the business and ample reserves have been steadily created.

There are few oil mills in India run up on such lines. Instead they are usually equipped with second hand machinery under the care of a very ignorant mistri, whose engineering knowledge is almost nil. The mill is usually too large for the amount of capital available.

(*j*) Cleanliness required in the manufacture of food products.

It is a peculiar thing that whilst many persons seek and obtain technical advice regarding machinery required and methods of using it, few will make any extra expenditure to make obvious improvements in efficiency and equipment. In consequence of this the general state of oil mills in India, so far as cleanliness is concerned, is particularly bad; and since the bulk of the mills are engaged entirely in the production of oil for human consumption, one would have thought that more care would be exercised in attempting to introduce hygienic methods. In this direction there is a very large field open for improvement.

There exists a further marked difference between the methods of the West and the East. In the West an inferior vegetable oil is difficult to sell, and the only place where it will find a market is in the soap industry.

In India very few oils are manufactured of a quality fit for any other purpose than the manufacture of soap. Pure linseed oil is almost unobtainable for the paint and varnish trades. This is primarily due to large quantities of other seeds which are usually found with linseed and mustard, and the equipment of the agriculturalist, or oil miller does not provide for effective separation of such seeds from linseed. The oil is also adulterated with cheaper oils. The quantity of the oil produced in India is spoiled to a large extent, so far as colour and taste are concerned, by the absence from mills of suitable plant for rapidly purifying it. The result is that in almost every mill there are large quantities of foots or tankage mixed with the fresh seed. This oil from tankage is quite unfitted for human consumption.

(*k*) Adulteration of oil.

The adulteration of vegetable oils is undoubtedly on the increase, and it is not uncommon to find on sale throughout India so-called "mustard oil", which is a mixture of vegetable oils and white mineral oil, or may be entirely mineral oil flavoured with allyl-iso-thio-cyanate, a poisonous and otherwise injurious product which is now being extensively imported for the nefarious practice of adulteration. The recent high price of mustard oil, which is almost entirely used as food in Northern India, from Central Provinces to Bengal, has lead to much adulteration during the years 1928, 1929 and 1930. Thus the oil offered for sale is to a large extent an admixture linseed and any other oil of low price. Very few Indian oil mills have reached the stage of having a pride in the quality of their products, and a change is not likely to occur until there exist and are enforced laws relating to adulteration of various products, including food.

(*l*) New ventures.

There is an undoubted tendency to attempt to introduce more modern practice and to branch out into "Pastures new". In view of the absence of technical ability in the shape of experienced oil chemists and technologists one cannot but suggest to the industry to follow the advice of the Roman gentleman who said "*Festina lente.*"

Such processes and undertakings as the manufacture of linoleum, paint and varnish, soap, the extraction of oil by means of solvents, the hydrogenation of oils and others requires a number of factors to be present before there is even the most remote chance of success. In addition to the staff and capital mentioned above the equipment in all cases must be of the highest quality, and maintained in that condition. For some processes the climatic conditions of India are unsuited, and in others the cost and upkeep of plant is so great that unless the work be undertaken with the utmost efficiency, with sufficient capital and with a properly organized sales department, the new ventures will come to a rapid and disastrous termination.

In view of the imports of such articles as hydrogenated oil, soap and linseed oil it is clear that there is room for factories making such products. The imports of hydrogenated oil amount to Rs. 1,77,00,000, soaps total some Rs. 1½ crores, paint and painters materials are a like sum, while the value of the linoleum and oil cloth required in India is approximately Rs. 9 lakhs. Thus there would appear to be opportunities for development, if there were available the capital, technical skill and sales organization which are essential for success.

The manufacture of soap has possibilities, but the manufacturer must realize that the sole reason for the sale of imported soaps in India is that they are produced cheaply owing to the quantity produced, raw materials are available in quantity in the countries of production, sales organization and management are of the highest quality, and the soap is always of the same reliable standard. The

Indian soap maker has signally failed in keeping the question of quality in view. India is unfortunately at a great distance from countries where the best soap making oils are obtained, and she has little else from which to make satisfactory soaps than coconut and mahua oils. Coconut oil, being suitable for the production of edible oils, stands at too high a price to enable it to be extensively used for soap manufacture. Mahua oil, while usually in sufficient quantities for the present requirements of Indian soap makers, is by no means in sufficient quantities to replace imported soaps. India requires immense quantities of mahua trees for the future, and if Municipal and District Boards undertook an extensive scheme of planting of these very valuable trees on both *pakka* and *kachcha* roads, the future income derived from the sale of flowers and seeds would go far towards producing the ever increasing funds required for road upkeep.

(*m*) RAILWAYS, MOTOR TRANSPORT AND AVIATION.

Formerly the whole of the Indian Railways utilized castor oil as their chief lubricant. During recent years the amounts used have become steadily less.

This has come about from two chief causes. First, the wonderful sales organization of the large mineral oil concerns have managed to put before the railway world good lubricating oils at prices far below that at which castor oil can be produced. The steady pressure of efficient salesmen has produced conditions which will tend to entirely eliminate castor oil from railway stores.

It is doubtful in these days of economy whether the true economic aspect has been examined fully.

India depends upon agriculture almost entirely for her revenue. Thus in the production of castor seed revenue is produced, the agriculturalist is enriched, and if he is encouraged to use castor cake as a fertilizer, he will obtain a good nitrogenous manure for his land containing the very necessary organic matter which imported nitrates do not contain. The increase of mills producing castor oil and oil cake would to an extent tend to relieve the pressure on the land, and in view of the world demand for castor oil for innumerable purposes a very substantial export trade in this oil might be built up.

The railways in their turn would benefit substantially by increased income derived from freight on castor seed, oil and oil cake.

Railways would probably benefit considerably by reverting to castor oil in place of mineral oil, since the engine bearings would have a lengthened life. India has much to gain and little to lose by an increase in production of castor oil and castor cake.

The Indian oil miller is largely to blame for the tendency of railways to discontinue the use of castor oil.

The quality of the oil which the mills delivered to the railways for use was usually of a most inferior quality. At times those in charge of the supply of lubricants on the railways were put in most

awkward positions, as the mills were frequently in arrears with deliveries or did not fulfil their contracts.

This condition of affairs forced at least two railways to establish their own oil mills for supplying their requirements of castor oil. Public opinion ultimately closed one of these mills, and the vendors of mineral oil lubricants have continued to make headway.

With the increasing use of motor transport and aviation it may be possible for castor oils to retrieve its former important position, but before that is possible the oil millers of India must mend their ways and methods, capital must be available and mills modernized, trained and experienced staff must be introduced and oil millers must be prepared to deliver to the buyer oils of really first class quality.

---

(2) Definition of the vegetable oil industry.

The vegetable oil industry must be looked upon in the same light as any other existing industry, consequently the same fundamental rules apply to it.

To develop an industrial concern there must be—

(*a*) Adequate finance.

(*b*) Directing heads able to control the financial side of business, able to control labour, and with ability to select machinery for each operation.

(*c*) Staff to keep the machinery in first class condition.

(*d*) There must be persons capable of purchasing raw materials of the desired quality.

(*e*) Persons able to build up sales organization, with knowledge of local markets and of markets at a distance and who are salesmen constantly able to extend those markets.

No business can be extended upon a satisfactory basis unless there are markets for the manufactured products.

In taking any steps to assist the vegetable oil industry the foregoing ruling conditions of any manufacturing business must be rigidly kept in view.

The industry in India has never really existed upon a sound footing through failure of those engaged on it to recognize the above business principles.

The industry as a whole suffers from a variety of difficulties, a number of which are largely due to those engaged in it, while there are other difficulties over which the industries have little or no control.

In any attempt which may be made to assist the development of the vegetable oil industries in India it is necessary to examine the rise of the vegetable oil industry of Europe and America, which to-day are composed of vast concerns largely controlled by combines. The Indian industry is at present far remote from that condition,

being almost entirely composed of small privately owned concerns. The form of assistance must therefore be shaped to suit existing conditions as well as to provide for the industry developing at some future date on the lines of the sister industries of Europe and America. One thing is quite certain, that is the oil industry is essentially one where large capital is required.

(3) The agriculturalist in relation to the oil industry.

The agriculturalist is possibly the most important person in relation to the success or failure of the oil industry. The agriculturalist is the producer of all the raw materials for the industry, and on the other side they are the largest customers for oil mill products.

Such being the facts, it is obvious that until there is substantial improvement in the purchasing powers of the agriculturalist, there is little or no possibility of increasing the sales of oil mill products in India.

Efforts to improve the welfare of the oil industry by means of increasing the spending power of the masses will be a very slow method, which should be tried none the less; but there is ample scope in the direction of improving the industry by direct means, if the mill owners can be induced to stop waste and to improve their methods.

A determined and lengthy attempt is required to improve the condition of the great mass of the population. In order to make a commencement on this gigantic work it is necessary to give the agricultural worker education of a type suited to his particular requirements. These may be briefly stated to be ability to read, write, to do comparatively simple arithmetic, and he should be well acquainted with the weights and measures existing in different parts of India, particularly those of his own district and province.

There should be simple agricultural instruction given in every school, which should not attempt anything in the way of scientific matter, but should be confined to the commercial side of practical agriculture. Such a course would include—

(1) the methods required to collect and preserve manure and the conserving of urine,

(2) the planting of trees in all available spaces to augment the fuel supply and supply of oil seeds,

(3) methods for protecting growing trees from cattle and goats,

(4) methods of manufacturing ghee,

(5) the feeding of milch cows and buffaloes and draught animals, including the use of oil cakes.

Greater efforts required to be made to—

(*a*) induce every agriculturalist to become a member of a co-operative society,

(*b*) to register all money-lenders, to fix a definite maximum rate of interest, and to register all loans,

(*c*) to extend the distribution by Government of good quality oil seeds.

The problem of cheap fuel.

The fuel problem is possibly the root cause of the low standard of living in India. It might be well to very carefully consider the possiblities of reducing Railway freights on coal and wood fuel, for it is obvious that until fuel of some kind is available in sufficient quantities, there must continue to be used immense quantities of cowdung.

If the mass of the population could be induced to burn wood, or coal only, and to utilise the whole of the cowdung supply to the best advantage, such as has been suggested, it is not impossible that, by the increased productivity of the soil the freight on the extra crops carried by Railways would more than compensate, for the loss caused by lower freights on fuel.

The situation would be materially improved if such departments as P. W. D. (Roads and Canals), District Boards, and Municipalities, considered an extensive programme of tree planting, so as to increase the supply of wood fuel, and at the same time bring in a substantial income. This matter is again referred to under mahua trees (Appendix XX).

The issue of Provincial Agricultural loans might be considered.

The agriculturalist at present cannot obtain cheap money. While an established business, can borrow money at 7 or 8 per cent. the most important business to India namely, Agriculture, has to borrow at excessive rates.

Agricultural loans, might be advanced through very much strengthened Co-operative departments.

The Loans given to agriculturalists would be only in the form of such things, as manures and fertilizers, improved agricultural implements, improved seeds, or better types of cattle.

A definite system of sinking tube-wells over those districts not served by canal irrigation, might well be established through Agricultural loans, and charges levied for tube-well irrigation, on a similar scale to that of the Canal Irrigation department.

(4) Research work which would assist both Agriculturalist and Oil Miller.

Most kinds of oil seeds vary considerably in oil content, even though they may be of the same variety.

The variation in quality is undoubtedly due to poverty of soil, and consequent poor class of seed available for sowing, or to the unsuitability of certain seeds for soils of different quality and moisture.

Research Workers, might turn their attention to the oil content of seeds, in relation to the quantity of manure given per acre, as well as to questions relating to the most suitable kind of manures and fertilizers for each class of oil seed.

All seeds have an outer husk or covering, which is usually non-oil containing. There are considerable variations in the thickness

and quantity of this outer coat, which is comparatively useless to the oil miller. This fault is very easily seen in such seeds as castor, ground nuts, mahua, coconuts.

In the direction of animal nuitrition, there is room for endless practical research work, which should include extensive feeding experiments with all available fodder crops, and mixtures of such crops, as well as experiments with the various oil cakes, and compound oil cakes, which latter are totally unknown in India.

This work might be undertaken in every Province in India with the fodder crops available, and with the oil cakes available from all parts of India, with a view to increasing milk production, and in keeping draught animals in good condition. The question of setting up standards such as are provided in the English Fertilizer and Feeding Stuff Act, will have to be carefully considered, and decided, before the manufacture of compound oil cakes, or compound cakes, is permitted.

There should be an extension of methods for preserving green fodder, and even of drying grass by artificial means, so as to have reserves of food available during the dry season.

The utilisation of castor cake manure, needs extensive practical research work, and the form in which it is applied to the land also needs careful examination. Existing methods are found to be uneconomic. The exact quantity per acre for each crop, which gives the best result, requires to be more definitely ascertained, as well as the ideal method of application. The proportions of artificial fertilizers to be used in conjunction with castor cake, also require to be definitely found.

All successful agricultural research work should, after completion, be translated in all vernacular languages, taking care to use as simple words as possible, in order that the information may be distributed as leaflets to all schools, Co-opertaive Societies, and District Officers, so that the results of such work may reach the agriculturist, and have a reasonable chance of bearing fruit. It is very doubtful if at present there is any chain of connection, or means of rapidly distributing information, from the Research Laboratory to the man at work in the fields, or even if it exists whether the information is in such a form, as can be taken in by the uneducated agriculturist.

(5) Prevention of waste as a means of helping the Oil Miller.

Reference may be made to valuable suggestions put forward by Dr. Gilbert J. Fowler in his Presidential address "Wealth from Waste" to the Madras Agricultural students' Union at the Coimbatore Conference 9th July, 1929.

Particular attention might be given to increasing the width of the tyres of wheels on carts drawn by buffaloes and bullocks, likewise of ekkas.

The damge done to road surfaces is enormous. Without mentioning the unnecessary and innumerable breakdowns, and loss of time and energy.

Little or no attention has been given to the collection of innumerable weeds, grasses, and leaves, and the utilisation of night soil in villages, or to the conservation of the valuable urine of farm animals. Dr. Gilbert J. Fowler D.Sc., F.I.C. late Principal of the Harcourt Butler Technological Institute Cawnpore, has published the result of his valuable research work on the methods of making such manures, and of increasing their value. These results might well be broadcasted, as valuable information to the agriculturist. As yet little effort has been made in the direction of giving practical demonstration to the agriculturist in matters such as these, including the proper construction of stables for animals, and proper drains leading to a properly constructed manure pit.

India produces ghee to the value of Rs. 100 crores, as yet there has been but little done toward practical demonstration of economic methods for manufacturing this valuable food, so as to produce it in a condition fit for sale as human food.

There is an exceedingly vast field open in every direction for assisting the agriculturist to rise from his state of poverty, but such work requires an army of resolute Indian workers, bent upon improving the present appaling conditions.

The oil millers could assist themselves very much if only they could be induced to make small expenditure, and instal simple apparatus for preventing waste of oil, and other valuable material.

The bulk of the 1,243,449 tons of vegetable oil produced in India is packed in old kerosene tins. A casual glance around any oil mill in India will show that at least half an ounce of oil is lost in the process of filling each tin. In this operation there is lost in India some 34,000 maunds of oil valued at Rs. 5,10,000.

In each of the 600 oil mills of India there are at least two oil storage tanks or other places where drops of oil are escaping.

Calculating that only 5 drops of oil per minute are being lost in each mill, it results in a total loss of Rs. 59,430 per annum. The losses are, however, very much higher than this.

The lack of proper seed cleaning devices causes an additional heavy annual loss.

The seed crushed in Indian mills, amounts to 3½ million tons, and contains some 175,000 tons of dirt (calculating at only 5 per cent. dirt which is on the low side) which in the course of manufacture absorbs some 10 per cent. of oil or 472,500 maunds valued at Rs. 70,87,500. The millers have purchased this dirt for Rs. 2,36,25,000.

In the cartage and Railway carriage of seed, from the agriculturist to the oil mills of India, some 175,000 tons of dirt are unnecessarily carried, costing at least Rs. 1,75,000.

In the above mills there are some 570 oil expellers, which in consequence of unnecessary wear and tear, due entirely to dust in the seed, costs the oil mill industry some Rs. 1¼ lakhs of unnecessary expenditure each year.

The above, are some of the losses suffered by the oil crushing industry in India, and while they do not by any means represent the total loss, make up the substantial sum of Rs. 3,15,81,930.

There is no doubt, that if it were possible to get in touch with with all the mills in India, to give them the necessary technical advice which is needed, and to get it acted upon a very much larger sum could be annually added to the profits of the industry.

(6) Cottage Industries, as a means of assisting the Agriculturalist and Oil Miller.

This problem, is one which requires to be looked at with the utmost scrutiny, for there is grave danger of doing vast damage to the rural population, by ill advised measures for extending Cottage Industries of a certain type, which at the same time do irreparable damage to the oil miller, and other industries which industralists have endeavoured to start on a basis which is more or less organised.

To explain the economics, a definite example may be taken of two village telis with their bullock driven kohlu mills, where oil pressing is undertaken on cottage industry lines. (See Appendix XXI.)

There are probably 8,000 to 10,000 of these small mills in every Province, but definite figures are not available.

No. 1.—Teli is a married man with a wife and two children.

No. 2.—Teli was married, but his wife died without giving birth to children.

No. 1.—Teli, works occasionally, but for the most part he leaves the oil pressing business to his wife and children, while he occupies himself on the land or takes the oil, and oil cake, to the local market for sale. The business goes on from year to year but does not increase either in plant or production nor does the teli pay his wife and children any wage, for the work they are doing, they merely get their food.

In other countries, such work would be known as slavery, or where a small wage was given the labour would be called "Sweated Labour."

No. 2.—Teli, has either to work the business himself, or he has the alternative of hiring labour, at current rates. It is obvious that no. 2, has little chance of fair competition with no. 1.

Such cottage industries, while giving the people occupation are not doing anything towards enriching them, or putting them in the position of being able to purchase manures, agricultural implements, food or clothing, nor are such industries likely to survive when improved methods are in use by organised mills.

Such an industry, is holding up the development of one of India's most important industries.

As things stand today, the village telis are crushing the bulk of India's oil seeds, and are supplying the bulk of the oil, and oil cake consumed in the country. At the same time they extract on an average a maximum of only 33 per cent. of oil, when the large mills might average 35 to 37 per cent. This class of cottage industry, might well be discouraged.

Experience in other countries, has shown that, usually, the organised factory, run on business lines, can produce a better article, more cheaply, than that of the cottage worker, while at the same time an infinitely better wage is paid.

In India, examples of these are the cotton and leather trades. It may be noted that, agriculturalists in other countries have seldom time to spare from carrying on their agricultural operations, and it appears peculiar why India should be any exception.

The spare time, if there be any, of the agricultural worker might be spent in education, in improving his village surroundings, by collecting waste products for the manure heap, by manufacturing ghi, and working up waste material into something of value to his land, or something in the nature of raw materials for an organised industry.

Examples of such work as will yield profit to the agriculturalist are—

The thorough cleaning of his grain, and oil seed crops, and grading them. The construction of proper places for seed storage, where seed may be kept dry, and in a marketable condition.

The collection of oil seeds grown on trees such as neem, mahua and karunja.

The introduction of, more modern methods of separating seed crops from their straw, would possibly make available better material for use as coverings for houses. It would also make available an exceedingly large quantity of linseed straw, which could be comparatively easily worked up into fibres. These fibres might be suitable for weaving into cloth, by village weavers, and would supply a bye product which could be made up into ropes, and binder twine, by Cottage workers.

In addition it would give a considerable quantity of shorter fibres, and woody cores, which are possibly very well suited for the manufacture of paper pulp, paper and straw board. These waste products are perhaps worth almost as much as the present linseed crop. (See Appendix XXII.)

The working up of milk, and milk products, is essentially one which should occupy a very large number of agricultural workers, and at the same time, if developed upon business lines, should be of very great value in enriching the agricultural worker.

In this connection, the evidence given before the Royal Commission on Agriculture in India by Mr. Smith, Imperial Dairy Expert, and his letter to the Agricultural Adviser to the Government of India, Pusa on page 16, volume I, part II, of the Agricultural Commission's Report, should be carefully read and digested.

He points out that, the ghi manufactured in India, is to a value o Rs. 100 crores, but that owing to bad and unorganised methods used in this cottage industry, we have "the truly colossal loss to the wealth of India Rs. 8 crores per annum." If this money could be saved, it would probably mean that, a very great portion of the amount would be spent by the agriculturalist in oil mill products, oil and oi cake.

The question of setting up in certain districts, small and efficient dairies, either by Government or by Co-operative Societies, in the absence of Indian Capitalists, may be carefully considered.

These concerns, would purchase milk, and work up all products, or alternatively might purchase cream only, and return the skimmed milk. The cream could be profitably converted into a high class pure ghi.

(7) Manures and Fertilizers.

The work of conserving manure and urine, is possibly the most important matter concerning India to-day, since if steps are not taken in this matter, it appears of little use to proceed further.

The note by Dr. R. V. Norris, D.sc., Agricultural Chemist, Madras, is worth attention in which he refers to the necessity for nitrogenous manures, the exhausting effect of oil seed crops upon land, and the necessity of utilising oil cake, for replacing a portion of the plant food removed by oil seed crops. (See Appendix XIV.)

In this respect, attention is also required to see whether a more extensive use cannot be given to castor cake, and whether the activities of the village teli cannot be directed to the crushing of such seeds as, neem, and karunja, which yield cakes suitable for village consumption as manures.

The collection of such seeds as grow on trees, would also form a part of the profitable work which could be undertaken in villages.

In connection with the manure problem, it is essential that the agriculturalist be taught to discriminate between the manure of grass feed animals, and those fed on grass with a small ration of oil cake.

At times, there has been considerable discussion as to the extent to which cake feeding adds to the value of farm yard manure. In recent experiments in Europe, the benefit of the cake fed manure, was shown only in the first year of the experiment, and not afterwards. The practical farmer in Europe, however, holds fast to the view that the cake fed dung is superior to the other, and recent experiments at the Rothampstead Institute have shown a direction in which the view of the practical farmer is confirmed.

The breaking down of farm yard manure, straw, etc., to form humus, is brought about by sundry organisms which require nitrogenous compounds such as found in cake fed dung, and thus can work more vigourously in this, than in grass fed dung.

Hence, this process tends to produce better soil conditions. It is significant that, in England an out going tenant farmer receives a payment from the incoming tenant, dependent upon the amount of oil cake consumed in the previous year.

The following figures obtained in England, from feeding experiments, show the value of the manure from cake fed milking cows, and oxen, per ton of cake consumed :—

Cake.	Nitrogen equal to Amonia in lbs.	Phosphoric acid.	Potash.	Total value per year.
				£ s. d.
Linseed cake	103·87	37·11	24·65	6 12 7
Cotton cake (decorticated) ..	156·13	62·26	38·58	6 15 7
Rape	118·11	51·31	29·51	4 12 3

(8) Defects in oil seeds, which have a bad effect upon the oil industry, and also upon the agriculturalist.

Linseed.

The custom prevailing in the United Provinces of growing crops of mustard mixed with linseed, should be discouraged.

If it is considered a form of agricultural insurance, then it is necessary to obtain machines which are suitable to effect complete separation of the two different seeds. If such machines are at present not available, Government might offer a prize to the inventor of a cheap hand power machine, of a type that could be used on small farms.

The fact that linseed, offered for sale in many markets contains such a quantity of mustard and other seeds, renders the production of pure linseed oil almost an impossibility. Exporters, in recent years, have been obliged to set up at the ports, most expensive seed cleaning, and separating machines in order to enable them to ship seed of quality to European buyers. It is not generally recognised that, the cost and maintenance of such plant, is indirectly charged to the agriculturalist.

Research workers might well turn their attention to white linseed.

The seed is only grown in a few parts of India, and as a seed for the oil industry, it presents a far greater attraction than the ordinary brown linseed. The white quality, is richer in oil, and yields a particularly good oil. The difficulties in growing large amounts of this seed, appear to lie in the fact that, the seed and plant are more subject to disease, than the hardier brown quality.

Toria seed.

The Punjab is possibly the only Province producing a pure Toria seed.

In other provinces, where varieties of Brassica are grown, they are very largely of mixed varieties, in the same crop. Complaints are frequently made by European Oil Millers, regarding the quality of Toria seed, shipped from places other than the Punjab.

In Europe, an oil must comply with a specific standard, hence the mixing of seed hits back, by reason of well justified claims, upon the Indian Agriculturalist.

Cotton Seed.

The bulk of the cotton seed grown in India, offers little attraction to the oil miller in India, or elsewhere. The tendency of modern research workers is, to produce a seed which yields a definite class of cotton. No attempts, as yet, have been made in the direction of improving the seed from the oil millers point of view.

The seed required for oil milling purposes, should be one which is capable of being ginned clean, without a large quantity of adhering short lint. The seed should be more like the American seed which contains approximately 2 per cent. more oil. The best seed at present produced in India, so far as oil milling is concerned is Punjab American 4 F.

The special heat treatment of cotton seed, has already been taken up by Entomologist to Government, United Provinces, with a view to the destruction of the Pink Boll Worm, but unless the suggested heating treatment is done daily, as the cotton is ginned, and the seed is immediately crushed, there is little hope for the development of a cotton seed crushing business. The mechanical heating and drying of 2 million tons of seed will be an expensive matter, which may make it a non-commercial proposal. If the drying of the seed is to be undertaken, it would effect a very large saving if a suitable delinting plant be made available, prior to any drying process.

Experimental work in this direction is required, in order to completely delint the seed, which will allow the seed to dry naturally in the sun leaving only about 5 per cent. moisture in the seed, such a method would in all probability greatly increase the value and demand for Indian cotton seed as well as improving the quality. The seed could then possibly be preserved for a considerable time free from the boll worm and other insects.

At present, cotton seed is treated as rubbish at the ginneries, it lies about for months in a damp conditions, and is consumed by more than one class of insect. Very little, of the 2 million tons of cotton seed produced in India, is crushed, not very much of it is fit for crushing. The bulk is fed direct to animals as seed, and is probably responsible for much of the digestive troubles, suffered by milk producing animals in India. Before there can never be a cotton seed crushing industry, such as exists in America, it will be necessary

not only to improve the seed, but also to investigate the possibilities of suitable decorticating machinery, and the production of furfural from the hulls, or otherwise making profitable use of them. It is possible that India's difficulties with the Pink Boll Worm could be over-come if 1,800,000 tons were crushed within three months of being ginned, and to specially treat only that seed required for sowing in the following year.

For a note on possibilities of cotton seed crushing see Appendix XVIII.

Groundnuts.

In recent years, some parts of India have made considerable improvements in groundnut cultivation, and the oil content of the seed by the introduction of new varieties. Still further improvement is possible, if steps are taken to produce a seed with a lower percentage of shell. One object, of Agricultural Research workers might be in the direction of producing weight of oil per acre, in place of weight of seed.

There is a very great variation in the oil content of groundnuts, which requires attention.

Existing methods of decorticating seed also need investigation, and great improvement.

The process of damping groundnuts, prior to decortication, should be discouraged, or prohibited, or if permitted, nuts so treated should be placed in driers, before they are marketted.

In Europe, to where very large quantities of Indian groundnuts are shipped, there are numerous complaints regarding the high acid value of the oil, from the nuts of certain districts in India. These complaints are undoubtedly due to the practise of damping nuts, and not drying them properly, or may be due to the process of irrigating land a few days before ripe nuts are harvested, that is, dug from damp ground.

It is not improbable, that this irrigation has started the process of germination in the seed, without such process being visible. If this be the case, then splitting process has started in the oil, with the consequent growth of free fatty acid.

In a less degree, a similar process will take place in nuts that are harvested after showers of rain.

In districts where the land is too hard to enable the harvest to be satisfactorily raised, some attention might be given to the invention of a groundnut digger, somewhat on the lines of the mechanical potato digger, so commonly in use in Europe.

A suitable machine, would overcome the troubles brought about by the puddling process, and floating the nuts out of the ground. In addition, a good mechanical contrivance would probably increase the yield of nuts per acre, since many are lost under the existing system. Details regarding groundnut harvesting methods are in Appendix XVI.

Castor Seed.

There is ample room for research workers to improve this very valuable seed. Oil mills require less husk and shell, and a kernel of high oil content. Pure varieties for seed are required, particularly in Behar and Orissa and United Provinces. In these Provinces, the seed grown appears to be a mixture of a number of varieties, which are poor in oil, and high in shell. There appears to be no attention given to the process of dehusking castor seed, excepting only, the seed which the agriculturalist retains for seed purposes in the following year.

In some districts the seed husk is allowed to dry and is then carelessly beaten off with sticks.

In other places the seed is placed in holes in the ground, and the husk allowed to heat and ferment, when it bursts off.

This process damages the seed so that it will not germi [illegible] also spoils the quality of the oil.

Seed Storage.

Throughout the country, insufficient care is taken in the storage of seed. Often, the seed is not sufficiently dry before it is stored, or it is stored in damp places, or in places which are unfitted for seed storage.

Seed Cleaning.

Seed sold for inland consumption, arrives at the oil mills mixed with large amounts of dirt, straw, and other foreign materials, the quantities vary between 5 and 17 per cent.

It would appear necessary, to introduce regulations which would enforce standards in this respect.

Immense damage is suffered by oil mill machinery from dirty seed. This matter requires urgent attention.

New methods are required in agriculture for thrashing out the seed from cut crops, and there should be introduced efficient screening methods.

(9) The markets for Oil Mill products.

The oil mills of India, produce at present very little other than

(*a*) crude unfiltered oil, and

(*b*) Oil cake.

The market for vegetable oil in India, is very large, and the consumption is for the most part, as food. The seeds crushed in India yield 1,250,000 tons of oil. This means that the ration per head of population is 8·78 lbs. per annum, out of which has to be taken vegetable oils used for lubrication, soap, and other industrial uses, and also the export of 6,550 tons of oil, leaving a very small ration per head to be consumed as food.

The oil produced for sale is usually of inferior quality to that produced in mills in Europe, and America. The reason for this is, the mills are very badly equipped, and the mill proprietors are unaware how an oil mill should be equipped, and oil and oil cake should be stored.

The plant is usually so inefficient and defective that the production of fine quality oils is almost impossible.

There is a fair sized market in India, for linseed oil as food, and as a protection for wood work, in the shape of both boiled and raw oil.

The bulk of the orders for the latter are from Government and Railway departments.

The ultimate consumption of linseed, and other drying oils in India, should tend to increase, as the custom of building better class houses progresses.

When there is a marked improvement in the matter of better equipment of mills, and the employment of technically trained men there may be, a possibility of developing an export trade in linseed oil and its products, but it cannot come until there be a vast improvement in staff, plant, and methods.

Mustard Oil.

There is a very extensive demand for mustard oil in all parts of Northern India, from Bengal to the Western side of the United Provinces, and also for export. In the past these oils have been crushed, from almost any of the Brassica seeds, which are produced as field crops. The business is gradually being killed, owing to the system of producing for sale, heavily adulterated oils, sold as mustard oils, which more often than not, contain no mustard oil whatever.

These " Mustard oils " are composed of the cheapest liquid vegetable oils available at the time, and while formerly there was genuine mustard oil added, to the extent of 50 per cent. the custom of late is, to add a small quantity of synthetic mustard oil, to give the oil the smell of genuine mustard oil. White mineral oils are also used as adulterants.

Sweet oil.

There is considerable demand for sweet oil, such as those produced from till seed and groundnuts. The consumption of these oils is mostly in Bombay, Madras, and Central Provinces, where the strong taste of mustard oil is not appreciated.

Soap.

In recent years there has sprung up a greater demand for soap. This, for the most part, is from the small user. The class of soap, made and sold, hardly permits of the use of the name, soap.

The textile trade use considerable quantities, most of which is imported, as the bulk of the Indian made soaps are too poor in quality, to permit of their being used. There are, however, a few factories which make soap of a quality suitable for the trade.

To improve this trade, it would appear necessary to create standards for products which are sold under the name of soap.

Castor oil.

The demand for castor oil in India has fallen away in recent years. This is almost entirely due to the reduced consumption by railways, which now prefer imported mineral oils. The preference is due to lower price rather than to better lubricating properties.

This change should be very carefully examined to ascertain whether it would not be a better proposition for India, to continue to use castor oil as her main lubricant, even if the cost of castor oil be higher, than for mineral oil.

The point to be borne in mind is that, oil seed crops take away from the land much valuable plant food, and it can only be replaced to an extent, by the use of castor cake, and other organic manures.

It must also be considered that, aviation is only commencing, and in consequence, it is probable that the world demand for castor oil will increase out of all proportion to present consumption. India should set her mills in order, and cater for an export trade in castor oil, while the agriculturalist should assist himself, and the oil miller, in increasing the use of castor cake. India at present exports about 2,200 tons of castor oil.

Oil cake.

The estimated consumption of oil cake, in India is around 1,868,000 tons, while the average exports are about 275,000 tons, although in 1928-29 the amount exported was 327,578 tons. The exports, are chiefly composed of linseed, and groundnut cakes, which go to Europe to enable European cows to produce a high yield of milk. The oil cake remaining in India, is far below what she requires for her 51½ million female adult cows and buffaloes. The ration divided up equally gives 81 lbs. of cake per head per annum.

The ration is small as compared to that of around 700 lbs. per animal in Europe for milk producing cows.

The oil industry, would benefit by a larger use of oil cake, for unless there is a market for this commodity, it becomes unprofitable to crush oil seeds.

Indian agriculturalists would benefit very considerably if they could feed their milch animals on similar lines to those used in Europe. If that period ever arrives, far less animals will be required in order to give an equal income, and it is not improbable that the present income would be considerably increased.

(10) Standardisation of oil mill and allied products.

Too much emphasis cannot be placed on present day tendencies to adulterate all products, namely oil seeds, oils, and oil cakes.

The damage done in the past, has to a great extent destroyed the export trade in oil, which India formerly had with Europe, and it must be recognised that much of this trade has probably disappeared for ever. The lesson has not been learned, and in consequence it

would not be difficult, or impossible, to see the existing mills driven out of the trade, by new mills which produced a guaranteed pure oil.

At present, there do not appear to exist standards for the sale of oil in India, with the exception of comparatively small quantities, which are purchased for Government Store departments, chiefly linseed and castor oils, or where standards have been set up they do not appear to be enforced. The same remarks apply to oil cakes, soap and other products of the oil industry.

In the interest of both the trade and the consumers, it appears highly desirable that standard specifications be set up for all oil mill products, and oil products, as well as standards of purity for oil seeds, on the lines of the Cattle Food Trade Association, and Incorporated Oil Seed Association in England.

The agriculturalist, should be forced to market his seed and grain, with a minimum of dirt and foreign seeds.

Such legislation would relieve the Railways of unnecessarily carrying close upon 500,000 tons of sand, and dirt, from the oil seed crop alone, which material would be valuable manure, if kept on the farms. Similarly the vast number of bullock carts, carting their quota of rubbish along the roads of India, could be reduced. The total weight of rubbish carted about India from year to year, probably represents at least 5 per cent. of the total weight of seed and grain, produced in India, and must amount to several million tons.

At first, it might be advisable to introduce standards for goods meant for export only, in a somewhat similar manner to that in force in Australia and New Zealand, for dairy produce, and honey, or to introduce standards in India which will tend to make adulteration a punishable offence.

The introduction of a small cess upon the export of seeds, would provide funds for setting up the machinery for examination of such produce, prior to shipment, which might include laboratories at various places. At such laboratories work might proceed on the improvement of seed, and the improvement of the oil industry generally.

In this connection. the staff of the oil department, Harcourt Butler Technological Institute, Cawnpore, have on many occasions, urged the proprietors of oil mills and their managers, to form an Oil Millers Association, or an oil section in one of the Chambers of Commerce, so that they may be able to act together in matters beneficial to their industry.

Such an organisation could, amongst other things, set up standards for seed of all kinds, fix a definite form of contract for seed purchase, and for the sale of oil, oil cake, and other products.

The association, could also appoint an official arbitrator to settle matters relating to quality of sundry products, which would enable many disputes to be settled quickly and fairly, without having to go through lengthy and costly law cases.

This suggested course has so far met with little response.

(11) Possibilities for expansion of the oil and allied industries.

Under this heading must be considered the manufacture of products containing oils, fats and waxes, and bye-products which may be obtained in the manufacture of these materials such as fibres from linseed straw, mahua cake, castor seed husk, groundnut husks and their red inner skins, fuzz from cotton seed shells, bones, and other bye-products from slaughter houses such as blood, intestines and other such things.

In many cases these bye-products are largely wasted at present, and all have a commercial value, if their proper preparation is undertaken.

In some cases the bye-products have but small value, but it is possible that their value might be increased if the matter were taken in hand by competent research workers. There are good openings at present for a substitute for tallow in the sizing processes of the textile industry. At present the imports of tallow amount to over Rs. 25 lakhs per annum.

Hydrogenated oils.

The imports at present amount to over Rs. 1,77,00,000. This trade has been built up in less than 10 years. Already several factories have started to manufacture in India, and many more will follow, it may be well to add a note of caution to investors in this industry that, serious competition is bound to come, and unless the factories erected are both large and efficiently run, they will not be successful.

It is possible that a tallow substitute could be satisfactorily produced by this process.

Leather polishes.

The imports at present amount to over Rs. 13 lakhs while in 1929-30 they were over Rs. 17½ lakhs. In the countries of production almost the whole of the ingredients are imported, and if there were sufficient enterprise in Indian capitalists, there is already a large market when they care to erect the factories, and staff them with persons acquainted with the processes of manufacture.

Bees wax.

There appears to be no attention given to this industry. In some Government forests the wild bees hives are auctioned off, in others no attention appears to be given to the matter. The purchasers are usually of the peasant class whose methods of separating honey, bees and bees wax are extremely crude, and after separation the wax is usually adulterated before being sold. If the matter were taken in hand there is certainly a good opening for a small industry.

Linseed fibres.

In a separate note further information on this subject is given.

At present India imports a considerable amount of products made from this plant, but it remains to be ascertained whether, the coarser fibres which can be produced from linseed straw can be used to take the place of some of the imported goods, such as the following flax products :—

Canvas ..	1929-30	Rs. 3 lakhs.
Twist and yarn	1929-30	Rs. 4,473.
Bags and sacks	1929-30	Rs. 10 lakhs.

These fibres could be spun in villages into good thread and if covered with bees wax would make excellent thread for stitching leather.

It is even possible that they can be used to replace much of the imported cordage the imports of which are as follows :—

	Rs.
Cotton rope	11,46,326
Jute rope and twine	51,000
Cordage from other vegetable fibres	4,82,076
Fishing lines	2,50,000
	19,29,402

Mahua Cake.

This has but a very low value as a manure. The nitrogen content is 2·5 per cent. and even this is not available to the plant, until the saponin contained in the cake is removed by water.

The cake is therefore one which should be applied to the land before the rains start if results are to be obtained.

The present price is around 3 annas per maund while the normal price over the past 8 years has been 8 to 10 annas. It is possible that this cake in powdered form could be used to mix in with such things as chemical fertilisers the organic matter of the Mahua cake may be found advantageous.

Paints and varnishes.

There should be an increasing demand for these goods as the country develops. The demand from Railways should remain steady, if not actually increase. The demand for the motor industry should increase, as should be the case for house decoration.

Provided that the quality is given attention there exists a good opening for the manufacture of paints, varnishes, and stove enamels.

The imports of paint and painters' materials at present amount to Rs. 1,44,00,000.

Linoleum, oil cloth, leather cloth.

The manufacturers of these goods consume large quantities of linseed oil. The imports of these articles amount to Rs. 9,00,000 annually.

(12) Assistance, which can be given by introducing to India new types of oil seeds, and extending the growth of some existing kinds.

TUNG OIL.

For very many years, China and Japan have enjoyed a monopoly for the production of this oil, for which there is a large and increasing demand. On account of its possessing certain properties peculiar to itself, the oil is of particular value for certain kinds of varnishes.

Tung oil is obtained from the seeds of Aleurites Fordii, a tree indigenous to China which grows to a height of about 40 feet.

The export of this oil from China rose from 18,470 tons in 1915, to 53,650 tons in 1927. Buyers, in Europe and America, found that there was often adulteration practised in shipments of oil, which has resulted in the starting of plantations of these trees in America, in which extensive capital has been invested, and already the plantations are in bearing.

The commercial companies engaged in this work estimated that, all costs of starting these plantations and attending to the planting up, etc., was covered by 154 dollars per acre up to the end of the 3rd year. At the end of the fourth year the income would be 50 dollars per acre, rising to 100 dollars in the 5th year, which would gradually increase to 200 dollars per acre in the 10th year.

It is expected that in a few years time American plantations will be in a position to very largely supply the oil required in that country.

Experimental work has been started in India with these trees, but the work should be enlarged, with a view to finding the most suitable districts in which to plant up forests of these trees, to place India in the position of supplying tung oil to Europe.

Details of cost of growing these trees are in Appendix XX(*a*).

COCONUTS.

The demand for coconut oil in India, is likely to increase far beyond present quantities. It is not impossible to foresee a great shortage of coconut oil, when such countries as India and China become larger consumers of soap. The present supplies of coconut oil would be quite inadequate, if 10 per cent. more soap were consumed. There are some 800,000 acres under coconuts, but many of the trees are useless, and too closely planted.

Southern India enjoys the most suitable climate for the production of coconuts, and the manufacture of copra, the industry should flourish if organised on proper lines. The plantations could be extended to several other parts of India, and existing plantations could be improved.

Existing coconut plantations in South India, Burma, Bombay, and elsewhere have not been planted up with, or given, the same care as has been the case in such places as Malay, Samoa and other coconut producing countries.

In other countries the area under coconut plantations has vastly increased during the past 20 years, while in India there has been comparatively no extension. In Malay and other places care is taken not to overcrowd the growing trees, and 40 to 50 trees per acre is the maximum ; while in India little attention is given to this matter, which results in tall palms, with small yield of nuts of inferior quality.

The departments of Agriculture experience difficulty in getting growers to follow the advice given regarding planting and precautions for combating and eliminating pests, which latter are making such headway in some districts that entire coconut plantations will be destroyed in the near future.

Madras is the only province which produces copra in any quantity. In other places where the coconut palm grows the nuts are sold as nuts and are used for human consumption. It would appear that the industry of coconut growing has not been developed in India as fully as it might be. In the future India will probably require very large quantities of coconut oil for soap manufacture and for edible purposes, and unless organized coconut plantations are increased the demand could very rapidly exceed existing supplies.

Mahua trees.

Northern India utilizes the seed of these trees for the production of oil for soap manufacture. The mahua tree is to Northern and Central India what the coconut tree is to the South in respect to the soap industry. The present supplies are at times insufficient to meet the demand owing to the mahua crop failing on an average once in three years.

The income which could be derived from the seed crop alone should make the planting up of the trees profitable without taking into account the valuable crop of mahua flowers.

It may be suggested to Municipalities, District Boards and to the Government departments in charge of roads and canals that trees such as Aleurites Fordii, and mahua, if planted along all classes of roads and canal banks, are capable of bringing in a substantial income which would considerably assist in reducing the expenditure due to upkeep of these services, and that by extending the growth of these trees a truly valuable service will be done in India.

Appendix XX gives in estimates of cost and profit on planting up mahua trees.

It may even be possible, if these trees were planted in ravine and other waste lands, that these lands could be recovered and again be brought under cultivation.

(13) Assistance which has already been given to the oil industry by Government departments.

(*a*) Agricultural departments.

In almost every province work is being undertaken with a view of producing improved oil seeds.

Research work of this kind is naturally slow, and it may take a number of years to effect even a very slight improvement in one direction only. Efforts are being made to improve oil seeds in their powers of resisting sundry diseases, increasing their yield per acre and in increasing their oil content.

Experiments are also being conducted in the use of manures for oil seed crops.

At Pusa and in United Provinces work has been undertaken towards the improvement of linseed, and to find a plant which will, while giving a good yield of seed, have a root system suitable for the Gangetic alluvium.

In Bombay and Madras the work of the Agricultural departments has enabled the groundnut crop to become one of the most important crops of India.

The present crop is approximately four times greater than it was ten years ago. The introduction of a variety which does not require irrigation has made the groundnut crop in Bombay the most important of the *kharif* crops. In the cultivation of groundnuts great progress has also been made in Central Provinces, Mysore and Burma.

In Madras the Agricultural department has recently turned its attention towards improving the methods of cultivation and manuring of coconuts and to the utilization of waste lands for this purpose. The department has also sold to planters a large quantity of seedlings and seed nuts.

(*b*) INDUSTRIES DEPARTMENTS.

The Industries department of the United Provinces appears to be the first to have given attention to the improvement of the oil industry on a large scale.

At a considerably later period the departments in Bihar and Orissa, Madras and Mysore have made efforts to improve the industry in those provinces by the erection of oil expellers and in giving grants towards the erection of similar plant.

In 1907-08 the United Provinces Government erected a large oil mill equipped with four Anglo-American presses and auxilliary crushing plant in an effort to develop cotton seed crushing industry ; reference to this work is given in Appendix XIX.

In 1921-22 the Harcourt Butler Technological Institute, Cawnpore, was opened and students were admitted to the department of Oil Technology in September, 1921. The Head of the department was appointed in October, 1922, and the Lecturer in Oil Chemistry in September, 1924.

The original equipment for instructional purposes consisted of a small and unusual type of hydraulic press, pump and four high seed rolls. This plant was not suitable for demonstrating to existing mills, or for demonstrating to persons desirous of starting a mill, methods of efficiency, or modern practice.

In 1926-27 a sum of Rs. 28,560 was granted by the United Provinces Government for the erection of a small commercial sized oil mill at the Harcourt Butler Technological Institute, and later there was added to the equipment a small soap plant and a small paint plant.

Already very good results have been obtained from this expenditure ; details of expenditure can be found in Appendix XII.

The plant has been used for instructional purposes for students in the oil department and for instructing mill managers, proprietors and others connected with the industry, thereby assisting them to overcome difficulties which they at times experienced with their own mill equipment.

The mill has also been of considerable help to persons wishing to open up a mill of a similar kind.

The results which have been obtained in this mill should be a useful object lesson to the Indian oil milling industry, not only in respect to efficient extraction, but also in the matter of very much reduced cost of upkeep and number of hands employed. (See Appendix XL.)

A comparison of upkeep costs is given in Appendix XXXVI.

Further information regarding the oil department, Harcourt Butler Technological Institute, is given in the report of the committee appointed by the Government of United Provinces to inquire into the working of that institution as well as in the orders of Government, United Provinces, contained in resolution no. 1804/XVIII —415 of October 7, 1920, Industries department, United Provinces.

(14) Assistance which has been given to the oil industry in India by the department of Oil Technology, Harcourt Butler Technological Institute, Cawnpore.

The existence of the department did not appear to be known to the trade until 1923-24. Since then a very considerable number of inquiries of a technical or chemical nature have been dealt with.

Some of these inquiries have resulted in the department supervising the entire dismantling and reconstruction of mills and in the designing and preparing of plans for the enlargement of mills, the addition of improved plant or altering existing plant.

On other directions the department has found trained chemists, engineers and mill managers for a number of concerns, and has supplied men to train existing staff in the working of plant and process.

The department has been the means of starting a number of new oil mills and soap works, and has also been responsible for the establishing of a considerable trade in boiled linseed oils which comply with the Government of India specifications. The manufacture of driers for boiled oil manufacture has also been started by one or two firms, thereby displacing the use of the imported driers, which without exception were formerly used.

In several cases assistance has been given to engineering firms, including some who were unable to obtain guaranteed output from machinery supplied by them. In other cases assistance has been given to engineering firms and engineers in designs for new plant such as improved ghanni mills, power driven screw presses and other plant.

An effort was made to encourage the manufacture and use of an improved power driven ghanni mill. This machine which was constructed at the institute showed very great improvements over the existing machines in respect to space required, power consumed, output, annual repairs and renewals.

The machine, which was known as the Lewis ghanni, failed to find a market. This was due to the maker not being able to find funds to equip a workshop, and to the trade objecting to the cost of the machine, which was almost double that of the existing ghannis.

Buyers failed to appreciate such things as ball and roller bearings, and to the very large saving in repairs and renewals which the improved ghanni would have effected.

Further efforts were made to place on a commercial basis the manufacture of the Devereux power driven screw press.

The effort was only partially successful, due to causes beyond the control of the department. The machine could be made very useful to the small oil crusher on account of its reasonable cost and its efficiency.

In 1922 almost all the oil mills in United Provinces were equipped with the country ghanni, with the exception of six mills which were equipped with hydraulic presses. Not a single mill possessed any mechanical means for cleaning seed or transporting it from one machine to another, and few were and still are, equipped with suitable milling plant. There were no soap works other than those for making cold process soaps of inferior quality and in small quantities. There was only one factory equipped with plant for making boiled linseed oil. There was only one mill in the province capable of making any oil other than crude, unrefined and unfiltered oils.

In November, 1930 there were 50 automatic oil expellers installed in 33 oil mills in the United Provinces, in many of which there are in addition such auxilliary machines as rolling mills, seed cleaning machinery, automatic seed elevators and conveyors, filter presses, oil boiling plant, soap manufacturing plant, and plant for refining oil by means of steam and air in place of the old method of heating by direct fire.

Practically the whole of these mills have consulted the department in such matters as—

(1) The purchase of new plant.
(2) How to work the new plant.
(3) How to overcome mechanical difficulties.
(4) How to obtain higher yields of oil.

(5) How to refine and produce better quality oils.
(6) How to increase output with existing plant.
(7) How to manufacture soap of various kinds.
(8) How to manufacture boiled oil of various kinds.
(9) How to manufacture driers.

These are a few of the matters with which the department has had to deal.

The department has undertaken visits to a number of these mills on many occasions when difficulties have arisen, or has sent trained mechanics to set right the difficulties, or has supplied men to take charge of the plant while the mill hands were instructed, or has instructed the mill mistris at the institute. The majority of these new installations are directly due to the activities of the oil department.

At the request of mill-owners the Head of the department has, upon several occasions, made detailed reports upon their oil mills, and has pointed out where money is being wasted and where profits can be increased. The department has not confined its activities to the United Provinces alone, but in the past has been in constant touch with, and giving advice to, mill-owners in Bihar and Orissa, Bengal, Bombay, Central Provinces, Punjab, Hyderabad, Kotah, Gujrat and other parts of India.

Under the supervision of the department some 6 oil mills have been erected or have been dismantled and re-erected on proper lines.

Two soap works each capable of manufacturing 50 tons of good quality bar soap per month were started by means of the assistance given by the department in regard to plant, method of working and staff. In Bihar and Orissa a mill was assisted in starting a soap works, which resulted in a remunerative business in toilet soap manufacture. Three ex-students of the Harcourt Butler Technologicl Institute, Cawnpore, have also started their own soap works.

Chemists were supplied to undertake the process of soap making, and the department further assisted one of these soap works in securing large contracts for soap supplied to Army departments and the textile industry.

Some of the mills which have been assisted or have been reported upon at the request of the owners are:—

Howrah Oil Mill	Calcutta.
Bombay Flour and Oil Mills ..	Bombay.
Swatstik Oil Mills, Limited ..	Bombay.
Haldwani Oil Mills	Haldwani.
Narain Das Lachman Das Oil Mills	Cawnpore.
Quitla Oil Mills	Cawnpore.
New Premier Oil Mills	Cawnpore.
Saran Oil Mills	Bihar.
Mata Din Bhagwan Das ..	Cawnpore.
Kuddip Oil Mills	Lahore.
Amritlal Gulzari Lal Ramiwala ..	Ferozabad.

Mehi Lal Ice and Oil Mills	Chandausi.
Cawnpore Oil Mills	Cawnpore.
Juhi Oil Mills	Cawnpore.
Madan Mohan Dhamalal	Ferozabad.
Sri Gopal Oil and Soap Works	Cawnpore.
Banwarilal Rambharosey	Cawnpore.
Ganga Oil Mills	Cawnpore.
Daryabad Oil Mills	Daryabad.
Sheo Prasad Shri Krishna Das	Ludhiana.
Juggan Nath Brijraj	Calcutta.
Bihar Ginning and Oil Mills	Bihar.
Ramchandra Nagaram Oil Mills	Bihar.
Sri Pasupatinath Oil Mills	Bihar.
Raghir Oil Mills	Hyderabad.
Kotah State Oil Mill	Kotah.

The assistance given to these and other mills represents a capital value of considerably over rupees one crore, and include the following :—

(1) Material to the value of Rs. 10,000 had been spoiled and was unsaleable. The whole of this material was recovered and sold.

(2) A mill asked for assistance in reorganizing. With an outlay of Rs. 500 the owners of the mill were shown how the annual turn over in oil could be increased by almost $6\frac{1}{2}$ lakhs of rupees per annum. Taking the profit on oil at 6 annas per maund, this represents a sum of Rs. 20,000 extra profit per annum.

(3) In two mills improved processes for oil refining were introduced, effecting in each of these mills a saving of Rs. 2,000 per annum.

(4) Practical advice and demonstrations enabled a mill to increase output 24 per cent. Taking the profit on oil at 8 annas per maund, this represents an increased profit of Rs. 3,900 per annum.

(5) A mill was redesigned and the plant re-erected resulted in an increased output of 43 per cent. Taking the profit on oil at 8 annas per maund, this represents an increased profit of Rs. 7,700 per annum.

(6) Ten tons of oil had been spoiled and was unsaleable. At a cost of Rs. 250 a sum of Rs. 2,000 was saved.

(7) A miller was shown how he could increase output by Rs. 27,000 per annum with existing plant. Taking the profit on oil at 8 annas per maund, this represents an increased profit of Rs. 4,900 per annum.

(8) A mill which had been assisted by the Oil department were able to sell their oil at Rs. 3-8-0 per maund more than other mills on account of the quality of their oil. These figures were acknowledged by another oil mill, who asked the department to assist them to produce a similar oil. This assistance represents a profit to the mill of Rs. 450 per day when that particular oil is being produced.

The department has trained 42½ per cent. of the total students who had passed through the institute up to 1929.

The earnings of 18 students who are employees exceeds Rs. 44,000 per annum, while those who have started their own business are earning a total of approximately Rs. 20,000 per annum. The average starting pay which students from this department have received is Rs. 150 per month with free quarters.

In August, 1931 a total of 35 students have passed through the Oil course—20 are in employment—8 have started their own business—2 died—5 of those who completed their training in July, 1931 are at present not employed. The earnings of those in employment amounts to Rs. 45,900 per annum.

The departmental oil mill has been of considerable assistance to oil millers and to Provincial Governments by demonstrations of efficiency and improved methods.

The Industries department of Bihar and Orissa and of Madras erected somewhat similar demonstration mills after they had inspected that at the Harcourt Butler Technological Institute, and had been advised by that department.

The future influence of the department upon the Indian oil industry depends very largely upon the rate at which the required equipment of the department will be provided. There was no mechanical equipment to enable oil mills to be assisted until 4 years ago, since when the industry has advanced considerably.

When the time arrives that standards are set up for oil mill products, or when there is more demand in India for oil products made to certain specifications, there will be a very vast field of opportunity for the department to assist and benefit the oil industry.

During the short period that the new experimental plant for paint manufacture and toilet soap manufacture have been installed at the institute, considerable interest has been taken by the oil trade in these industries. It is very possible that in the near future at least two mills will engage in manufacturing these goods.

There is no doubt that the Indian capitalists move very slowly in the matter of starting new manufacturing ventures, and they almost all like to see a plant at work which they can duplicate or enlarge upon. They also like to see the manufactured products and to have the satisfaction of knowing that if they purchase similar plant there are men available to work it satisfactorily, and when difficulties arise they can fall back for the solution of their troubles by the Oil department.

It is partly for this reason that the department urgently requires additional plant, which should be added as the industry developes, and in this way keep in advance of the requirements of the Industry.

The rotation in which it is anticipated that the new plant should be added is indicated in the numerical order of the items in Appendix XIII.

(15) Co-operation with other Government departments with view to assisting the oil industry directly and indirectly.

The department of Oil Technology has endeavoured to work and co-operate in any way possible which might lead to improvement.

Assistance has been given in the collection of oil seeds from this and other countries which were rich in oil with a view to improving the quality of the Indian seeds.

Tung oil seeds were imported from China by the institute, and some also were obtained through the Royal Botanical Gardens, Kew, with a view of starting the cultivation of the trees bearing these valuable seeds. The growing of the seed is being done in conjunction with the Agricultural department, United Provinces.

Some of these seeds were sent to the P. W. D. Canal Irrigation department, North-West Frontier Province, which department has started on this work as well as upon the growing of mahua and castor seed supplied by the Technological Institute.

The work in relation to the recovery of linseed fibre from the straw is also being done in conjunction with the department of Agriculture, United Provinces.

The Agricultural department is endeavouring to grow a plant which while yielding more than the present average crop of seed, will also produce a good class of fibre.

In this work the yield of seed is being kept in view as of first importance, and there is no intention of attempting to produce flax.

---

(16) Work which has been undertaken at the Harcourt Butler Technological Institute, Cawnpore, with a view to assisting the oil industry.

(*a*) PUBLICATIONS.

(1) The refining of Neem Oil, by Dr. E. R. Watson and Dr. N. G. Chatterjee (Government Publication).

(2) The Soap making properties of the oils of the United Provinces, by H. M. Mulany (Government Publication).

(3) The Solvent Extraction Process for Oils and its future in India, by Dr. N. G. Chatterjee (Government Publication).

(4) The Refining of Oils in India for Edible purposes, by Dr. N. G. Chatterjee (Government Publication).

(5) The Neem tree and its products, by J. A. H. Duke and H. D. Sen. (Government Publication).

(6) The Oil Seed crushing industry of United Provinces, by J. A. H. Duke (Government Publication).

(7) Friction test on oils for use in motor car engines, by E. R. Watson and H. M. Mulany.
(Journal Society of Chemical Industry.)

(8) The Bitter, and Odoriferous Principle of Neem Oil, by E. R. Watson, N. G. Chatterjee and K. C. Mukerji. (Journal Society of Chemical Industry).

(9) The Variations of Oil Content of Oil Seeds of the United Provinces, by J. A. H. Duke (Times of India Engineering Supplement, June 27, 1924).

(10) The problem of India's Ghee Supply, by J. A. H. Duke (Government Publication.)

(11) The use of the Centrifugal Machine in the Oil Industry, by J. A. H. Duke.

(*b*) UNPUBLISHED INVESTIGATIONS.

(1) Selection of a pure race of castor seed with a view to increasing oil percentage per acre.

(2) Production of cattle food from castor cake.

(3) Preparation of manure and Mowhrin preparation from mahua cake.

(4) Production of rubber substitutes from oils of the United Provinces.

(5) The production of pungent smelling mustard oil by means of modern oil milling plant.

(6) Investigations into various adjustments of oil expellers so as to obtain maximum yield of oil and maximum output with various oil seeds.

(7) The obtaining of definite running costs and upkeep of expeller mills crushing.

(8) The cleaning, and grading of various oil seeds by mechanical devices.

(9) The separation of various classes of oil seeds from other oil seeds and foreign materials.

(10) Refining of coconut oil.

(11) Preparation of waterproof oil varnish.

(12) Preparation of water soluble oil varnish distemper.

(13) The refining and bleaching of mahua oil.

(14) The manufacture of driers.

(17) The training of Oil Technologists.

A survey of a few of the oil mills will rapidly demonstrate to any up-to-date industrialist the urgent necessity for a large number of trained men to be made available for the oil industry.

The type of man required is one who has had a good mechanical engineering training coupled with the technology and chemistry of oils. Already a start has been made in this direction, and men are being trained for the industry at the Harcourt Butler Technological Institute, Cawnpore.

The first students in the Oil course were admitted in the month of September, 1921, since when the following admissions were made :—

1921	..	3 students with B. Sc. degree.
1922	..	4 ,, ,, ,, ,,
1923	..	4 ,, ,, ,, ,,
1924	..	5 ,, ,, ,, ,,
1925	..	5 ,, ,, ,, ,,
1926	..	2 ,, ,, ,, ,,
1927	..	6 ,, ,, ,, ,,
*1928	..	6 ,, ,, ,, ,,
*1929	..	1 student with Inter-Science examination
*1930	..	3 students ,, ,, ,, ,,
Total 1921—30	..	39 students.

Of the above total there are in employment as under :—

2 managers of oil mills,
7 have started as manufacturers in own works,
7 in employment as Works Chemists,
4 in employment as Technical Chemists,
1 in the employ of oil mill engineers,
1 Agent for Paint and Varnish Works, and
1 Government service as Assistant Stores Purchase Officer.

23

The reports received from employers have expressed satisfaction on the work and ability of ex-students.

At first there was a considerable difficulty in getting employment for the students who had been trained.

The impression which the mill proprietors had was that these men were similar to the product from the Universities, namely, that they had a smattering of the theoretical knowledge of the subject, but were quite unacquainted with the practical and mechanical side of the oil business. This incorrect idea took some considerable time to remove, and it was only done by means of frequent visits to mills by members of the staff with and without students and by personal contact with the mill proprietors and managers, who gradually found that by keeping in touch with the Oil department of the institute they themselves were able to improve their business by the advice constantly given.

In the Cawnpore area all the larger mills are employing men trained at the institute, and also some of the more up-to-date mills in Calcutta, Bombay and eslewhere have found it an advantage to employ these specially trained men.

There is butl ittle doubt that if it were possible to establish personal contact between the proprietors of oil mills all over India and the Oil department there would be a very considerable improvement throughout the industry, and at the same time openings would be rapidly found for trained men.

* Students still at the institute.

(18) Details of training given to Oil Technologists.

The curriculum given in Appendix XXIII relates to general subjects obligatory for students of all departments.

The special syllabus given in Appendix XXIV is for students in Oil Technology.

The department is as yet only partially equipped with large scale plant for demonstration experiment and teaching purposes.

The equipment consists of a small hydraulic press and pump of the Anglo-American type and a small set of Anglo-American rolls. This small plant is not of a satisfactory kind, but was the only plant which could be purchased at the time with the funds available.

Later the United Provinces Government voted funds to equip a commercial sized oil mill. This mill when erected complete with buildings cost Rs. 35,046.

The normal capacity of the mill can deal with 50 maunds of seed per 10 hours.

The present equipment can deal satisfactorily with linseed, mahua and mustard seeds on a commercial scale. Good experimental results have been obtained on castor, til, safflower, cotton seed, both decorticated and undecorticated, and neem seed.

In order to treat these seeds on a commercial basis some additions of plant are required such as—

Double Duplex rollers for castor and til seed.
Decorticating plant for castor and cotton.
Defibrating machine for cotton seed.
Hullers for cotton seed and safflower.
Hull beaters for cotton seed.

The mill is also equipped with a small refinery suitable for making commercial oils and for the recovery of oil from sludge. This plant requires several additions to make it complete. There will be found a complete list of existing equipment for large scale operations in Appendix XII, and in Appendix XIII there is a list of plant which it is proposed to add to the equipment as the oil industry gradually develops.

It is desirable that some of this new plant is added in the near future, particularly that for dealing with seed crushing operations, oil boiling, oil refining and deodorising, which is estimated to cost Rs. 42,800.

When this new plant has been added it will enable the department to be of very much greater assistance to the industry, as well as enabling a more thorough and extensive training to be given to students.

At one period Government considered the question of trying to get students into existing mills for practical training. This has been found impracticable, as in very few of the mills is there anything which may be commended to a student for study. Usually the methods of work are such that the training of students in existing mills would be a retrogressive measure.

(19) Difficulties which hinder the improvement of oil mills and their equipment.

Indian oil mills when compared with those of other countries are very much smaller in size.

The mills are in process of evolution and are gradually developing from the village bullock driven mill to those equipped with somewhat similar ghannis power driven by steam or electricity, or to those equipped with hydraulic presses and automatic oil expellers.

The bulk of the seed crushed in India is still done by the indigenous bullock driven machine.

During the past ten years there has been a decided tendency to add modern machinery to existing mills; the imports of new oil mill plant during the period 1922—1927 reached a value of Rs. 1,34,00,000.

The bulk of the mills are Indian owned and controlled, with the exception of 4 or 5 mills.

While there do not appear to be any up-to-date records of the number of oil mills at work in India, inquiry shows that they must number some 600, that is, mills equipped with plant ranging from 25 power driven ghannis to those entirely equipped with modern plant. Some details of existing mills are to be found in Appendix XXVIII. Throughout the mills there does not appear to exist any appreciation of cleanliness. The waste of material and labour is almost unbelievable; the filth in the average mill in India would not be permitted by the sanitary officers in other countries, even if economic conditions permitted such enormous waste of oleaginous material.

The proprietors of oil mills appear unable to recognize where waste is taking place, carelessness goes unnoticed; and even in cases where such faults are pointed out very few attempts are made to act upon the advice given. This condition of affairs is very largely due to the fact that few oil mill proprietors have had anything to do with any organized factory, and that their own experience has been gained entirely in their own mill.

The mill managers are usually suffering from the same malady, and in consequence are not fit to alter the existing conditions. Very similar remarks apply to the engineers, fitters and foremen in charge of labour.

The proprietors and staff in charge of oil mills do not bear comparison with those engaged in other organized industries in India such as Cotton Mills, Woollen Mills, Jute Mills and Sugar Mills and Refineries.

The reason for this very great difference is possibly due to the fact that the industry is in the stage of evolution and to the scarcity in India of a sufficient supply of really efficient mechanical engineers and skilled mechanics and fitters.

The absence from the oil industry of the skilled man may partly be due to the mills being of small size, and as such considered to be too small to carry the wages of more highly paid staff, or it may be

that owing to the very inefficient methods in use throughout the industry the proprietors find that they are unable or unwillin o pay a high wage to a really efficient man.

Generally speaking, the plant in the mill is in an exceedingly bad state of repair, and consequently stoppages are very frequent owing to breakdowns. The equipment lacks any kind of uniformity.

In spite of the large amount of new plant installed in recent years the bulk of the machinery in use is very old and out of date, and more often than not the plant is unsuitable for treating the particular seeds which the mill attempts to crush.

The amount of spare parts imported to replace those worn out is approximately three times greater per machine than are required by oil mills in other countries for similar plant.

The general lay out of the mills is particularly bad, and it is obvious that in most cases no thought was given to future extensions; and even where mills have not required to extend there has been exceedingly little ingenuity displayed in placing machines for rapid and easy work.

In the past no attention whatever was given to such things as mechanical devices for the transporting of material or for giving a constant and even feed to the various machines. Labour has been considered so cheap that the comparatively small cost of these automatic devices has been deliberately avoided. The result of having failed to spend a small sum on such items has meant that for years some mills have never worked more than 60 per cent. of the capacity of the plant, and have in most cases added new plant in order to increase output. Generally speaking, the mills suffer from the dislike of capital expenditure by the owner.

There will be found in Appendix XXXVI a table showing the efficiency of various classes of oil mill plant as used in India. Appendix XXVIII gives a list of oil mills in India.

(20) Shortage of capital.

The industry as a whole suffers from lack of working capital.

The mills for the most part are small privately owned concerns, and have been started by persons with little available capital beyond that required for the cost of plant and its erection, or where a certain sum of capital is available the mill has been made too large for the finance available. Some mills are in a good position and are able to borrow money from Banks on a basis of 25 per cent. margin at the current rates of interest.

The bulk of the mills are not in this fortunate position, and are never able to purchase or hold their requirements of seed for more than one or two months supply, consequently the small miller is at a very considerable disadvantage. Such mills are at once in difficulties if there is a temporary depression in the market for oil and oil cake, which leads to a temporary or permanent closing down of the mill.

The trade in Europe was at one time in a somewhat similar condition when the business was carried on by a number of small mills. Conditions have now changed, and we find that the industry in Europe and America is now almost entirely carried on by large concerns with ample capital, and there can be no doubt that in the future what has occurred in the industry in other countries must be repeated in India.

(21) Internal competition.

The many small mills, although some may be equipped with modern plant, are not managed and worked with sufficient skill to enable them to profit by the advantages of modern plant.

Such mills suffer considerably from competition with the small village teli on the one side and the large mill on the other.

The position of the village teli is peculiar, as he continues in the trade without making any substantial progress or profit, yet he is keeping up a serious competition with most of the mills with modern equipment. In reality the teli is holding back advancement in the trade.

It is agreed that he keeps himself and his family employed, but is it profitable employment and an economic one for India ?

It must be remarked that he does not pay any wage to his wife and children, and if such trades were carried on in other countries it is possible that such labour would be termed "sweated." If the oil industry is to progress, it is essential that the activities of the teli as a manufacturer should as far as possible be discouraged, and that he should, if possible, be encouraged to become a selling agent for the large mills.

The teli would very rapidly find that he was making a substantial loss or unable to compete if the large mills were properly organized and worked with an efficiency approaching that of Europe or America.

(22) Labour in oil mills.

Labour suffers considerably from the inefficiency of the management. Due to wastage of material, absence of method and a tendency to slackness the profits made by oil mills are not what they might be under different conditions. In consequence labour is wasted and badly paid.

Throughout the industry no attention whatever has been paid to proper housing of labour or to their general welfare. The conditions are often so bad that, after working in a mill for a month amidst the most undescribable filth and general discomfort, the rate of wages are not on as good a scale as those of workers in other industries.

There is room for better conditions for oil mill labour, particularly in regard to the unhealthy atmosphere in particular departments, where ventilation is required, such as seed cleaning departments.

where disintegrators are working and where mustard oil is being pressed. The mills could with advantage be better lighted and more attention given to general cleanliness.

As already stated, the general layout of the mills is usually very bad and is such that it often does not give the worker the chance of doing good work. Plant is often badly erected, in such a way that it makes rapid work difficult or even impossible.

The conditions under which the labourers working the hand screw presses all over India require investigation and possibly legislation.

The conditions under which draught animals are worked in villages in the process of rotating the pestle of the small oil mills should be examined. It is questionable whether they would be permitted to be worked under similar conditions in Western countries.

Practical experience gained by working in mills with Indian coolie labour and by frequent visits to oil mills shows that Indian labour is not inferior to other labour. The men are not so robust as labour in other countries, but they are quite willing to work, and work well under efficient supervision.

Managers who so often blame Indian labour as being insufficient very often could not point to where the inefficiency lies, and it is very doubtful whether, if such managers were placed in charge of picked labour, they could show any very much improved output.

The inefficiency of management has done immense damage to the progress of the industry, and it has given the investing public the idea that oil milling in India is a bad investment.

(23) Wages in the oil industry.

The rate of wage paid to oil mill workers in India is far below the rates paid in other countries, even if comparison be made with the rates paid in Calcutta and Bombay, which are the highest rates in India.

A table is given in Appendix XXXVIII showing the rate of wages paid in Liverpool, Hull and Bristol, which are the chief oil crushing centres in England. In the same table the rates paid in Bombay and Cawnpore are shown.

(24) The oil miller.

A prolonged study over a period of 10 years of the oil miller in India and his methods has given the impression, with few exceptions, that he understands very little of the manufacturing side of the business, and that he has but the scantiest idea of the magnitude and importance of the trade in which he is engaging.

The Indian oil miller, with few exceptions, does not bear comparison with those conducting the business in other countries. In Europe and America it is a case of keen competition amongst most efficiently

conducted up to date mills where labour is paid on a scale at least six times greater than in India.

In addition the articles manufactured in Europe and America are of a guaranteed standard, no matter whether they be crude oils, refined oils, soaps or oil cakes.

In those countries there is little room for inefficiency or adulteration.

There are few oil millers in India who are sufficiently advanced in the knowledge of the business to be able to come up to the standards required in other countries, and it is very doubtful whether, in the event of standards for oil products being set up in India, the Indian oil miller would be capable of producing goods to satisfy the standards required in Europe or America.

The plant and methods in use are so bad at present that it would be exceedingly difficult to get improvements made at once.

The miller strongly objects to any outlay on improvements, and in cases where money is spent for improvements, it is done in the cheapest possible way, which often spoils any hope for the results which would otherwise might have been obtained. His attitude is often such that, while he knows there is room for improvement, he takes 3 to 4 years to consider it and to act upon advice given.

The methods which he has used in setting up plant in bad positions and in unsuitable buildings often makes any alteration and improvement impossible or more costly than it would be in a well laid out mill.

The miller usually has had no experience of the business other than in his own establishment, consequently his view is narrow, and he has little idea that his methods are wasteful in material and labour.

It would not be an exaggerated estimate to state that 30 to 50 per cent. too much labour is employed, in the average oil mill in India.

Few oil millers in India realize the opportunities that exist by making first class articles and creating a market for them. Their methods of selling oil and oil cake appear to be entirely done through agents and dealers, and few are in touch directly with the consumer.

Thus it appears that since the consumer has only slight knowledge of who is the actual producer, the producer has but little pride in his products, which makes a very marked difference between the oil miller in India and elsewhere.

(25) Foreign competitions with the Indian oil milling industry.

The oil industry in India suffers very little from competition with imported manufactured goods, and is protected by substantial import duties. (See Appendix X.)

Vegetable product.

This is usually made from groundnut oil entirely, and is highly refined product used entirely for edible purposes both in India and in Europe. A large proportion of this article is manufactured

in the factories controlled by Unilevers Limited, which combine controls the edible oil trade and soap trade throughout a greater part in Europe. This concern has very large plant for manufacturing this and other oil products, and is in consequence able to produce the finished article at a very low figure. The staff is highly skilled and highly paid, and the processes used are in advance of their smaller competitors. These processes have taken many years of experiment and research to produce. The work has entailed scrapping much plant formerly used and considered up to date, and erecting new plant to take its place, or in erecting entirely new factories.

In Europe the climate is considerably colder than that of India, and cooling water required in the processes of manufacture is at sufficiently low temperature to suit, while in India the higher temperatures would require much additional outlay in refrigeration plant and cold storage rooms.

To produce this vegetable product at anything like the same cost of the imported article would require, in addition to a very large refrigeration plant, an outlay of close up in Rs. 40 lakhs. Processes equal to those in Europe would have to be devised. There have been plants erected for the production of this article in the Punjab and in Bombay, but there is little hope for the success of these plants, in spite of their advantage of protection by the 15 per cent. *ad valorem* duty on the imported articles, which is equal to Rs. 30-12-0 per 82lbs. maund.

Linseed oil.

There are imported to India some 11,285 tons of vegetable oils, including linseed oil, which is for the most part boiled oil; the balance includes over 9,000 tons of coconut oil. This imported linseed oil is of very good quality and is pure and made to a definite standard. It pays a duty of 15 per cent. *ad valorem*, which should be sufficient protection for mills in India. The reason why the linseed oil is imported is alone due to the faulty methods of producers in India.

Mills in India do not possess the necessary plant for its production; they as a rule do not understand the methods of preparation, and they are not sufficiently careful to see that the original linseed is absolutely pure.

Soap.

The imports of soap to India are to the value of some Rs. 1½ crores annually. The chief reason for the import of these soaps is that they are good quality articles, conform to standard, are well packed and are sold at a reasonable price.

In addition very considerable outlays are made on advertising them and in the upkeep of an organized system of salesmanship.

In India there are a few soap works turning out good quality soaps, but they are known only to comparatively few buyers, and are usually not so popular as the imported soap on account of the appearance of both the soap and its package.

Bar soaps as made in India are usually heavily adulterated or have been badly made, and are often injurious to both skin and

clothing. The imported soaps have been made in modern well equipped soap works, while the bulk of the soaps made in India are made under conditions which are quite out of date.

The foreign soap factories are very large concerns, and owing to their enormous output the cost of production is reduced to a minimum, in spite of having overhead charges for experienced staff, chemists and soap boilers.

(26) Weights and measures.

All over India there appears to be room for improvement under this heading, since much loss in money and time results from the lack of uniformity in weights and measures.

There are frequent cases in which both buyers and sellers at times make substantial losses through the variation in weights between one part of the country and another.

In the United Provinces alone there are a great number of variations in the weight of 80 tolas and 40 seers per maund.

For details of variation in weights and measures in India see Appendix XVII.

With such a variation of weights it is difficult for an ordinary educated person to always make correct calculations of prices, while for the uneducated cultivator it must be almost impossible.

The variations in inter-provincial weights are almost worse.

A note on methods of weighing is in Appendix XVII.

Index to Appendices.

APPEN

Estimate of Area and Yield of oil seeds

Provinces.	Linseed.		Rape and mustard.		Sesame or til.		Ground nuts.
	Area in acres.	Yield in tons.	Area in acres.	Yield in tons.	Area in acres.	Yield in tons.	Area in acres.
Punjab	27,000	2,000	913,496	140,000	93,000	8,000	..
Madras	7,326	1,140	11,789	2,105	650,000	81,000	2,551,000
Bengal	136,000	20,000	757,000	132,000	160,000	27,000	600
Bombay	101,000	8,000	210,000	21,000	576,000	68,000	796,000
United Provinces ..	1,061,000	181,000	2,390,000	449,000	937,000	100,000	12,984
Burma	33	..	4,541	973	1,080,000	30,000	511,000
Bihar and Orissa ..	644,000	98,000	733,000	160,000	203,000	25,000	200
Central Provinces ..	1,121,000	83,000	51,450	6,890	442,000	36,000	44,020
Assam	100,927	20,185	347,000	66,000	21,418	2,100	..
N.-W. F. Province ..	14	..	89,561	8,509	3,042	407	..
Ajmer and Merwara ..	195	9	394	87	18,419	636	..
Coorg	..	..	6	..	43	..	..
Delhi	1	..	3,000	400	25	..	..
Hyderabad	220,000	13,000	7,000	300	505,000	25,000	305,000
Baroda	..	..	20,623	3,872	52,658	4,667	..
Kotah	21,311	2,215	..	..	24,277	1,484	1,380
Alwar	..	..	53,000	8,000	..	..	..
Mysore	2,989	400	6,203	500	67,801	9,000	195,096
Total ..	3,442,796	428,949	5,598,063	999,636	4,823,683	418,294	4,417,280

DIX I.

in each Province (1926-27).

Provinces.	Ground nuts.	Castor seed.		Cotton seed.		Copra.	
	Yield in tons.	Area in acres.	Yield in tons.	Area in acres.	Yield in tons.	Area in acres.	Yield in tons.
Punjab	..	20	..	2,523,718	45,066	..	..
Madras	1,103,200	385,000	29,000	2,203,688	137,730	399,000	456,000
Bengal	270	100	8	59,300	7,940	..	..
Bombay	638,000	119,000	18,000	4,589,288	217,890	..	..
United Provinces ..	5,800	126,000	9,000	798,859	141,800	..	..
Burma	165,000	3	..	446,801	31,900	..	..
Bihar and Orissa ..	90	44,000	6,000	80,900	10,830	..	..
Central Provinces ..	15,720	55,000	9,000	4,861,002	542,076	..	..
Assam	..	5,659	480	45,997	7,187	..	..
N.-W. F. Province ..	..	..	..	29,505	3,529	..	..
Ajmer and Merwara ..	..	..	..	41,805	4,992	..	..
Coorg	..	..	..	1	..	..	..
Delhi	..	..	52,000	3,799	407	..	..
Hyderabad	25,000	611,000	5,831	..	..	..	..
Baroda	..	59,172	..	760,790	124,409	..	..
Kotah	528	..	..	42,480	1,724	..	..
Alwar	..	..	..	..	..	..	..
Mysore	69,600	114,506	1,300	97,566	8,000	..	..
Total ..	2,023,208	1,519,460	124,788	16,585,499	1,285,570	399,000	456,000

APPENDIX II.

	Tons.
Annual yield of oil seeds as field crops	4,834,533
Cotton seed	1,500,000
Estimate of other oil seeds such as mahua, dhupa, etc.	665,467
Total seed ..	7,000,000
Required for sowing 10 per cent.	700,000
Available for sale, for oil crushing, cattle fodder and export trade.. ..	6,300,000
Deduct exports	1,322,440
	4,977,560
Add seed imported	2,040
	4,979,600
Deduct cotton seed used as cattle food	1,200,000
Total available seed for oil crushing in India	3,779,600

APPENDIX III.

Import of oil seeds—(1928-29).

	Value.	Weight.
	Rs.	Tons.
Copra	5,29,261	1,500
Ground nuts	16,527	61
Linseed	13,878	97
Til seed	6,106	25
Tea seed	19,427	6
Others not classified	91,100	351
	6,76,299	2,040
Deduct tea seed as it does not appear to be crushed in India	19,427	6
	6,56,872	2,034

APPENDIX IV.

Export of oil seeds—(1928-29).

	Value.	Weight.
	Rs.	Tons.
Castor seed—		
Bengal	.. 14,13,001	7,991
Bombay	..1,45,67,285	71,187
Sind	.. 2,74,538	1,266
Madras	.. 82,97,770	40,992
	2,45,52,594	121,436
Copra—		
Bengal	.. 618	1
Bombay	.. 78,826	120
Sind	.. 2,681	3
Madras	.. 50	..
Burma	.. 2,347	7
	84,522	131
Cotton seed—.		
Bengal	.. 1,20,000	1,500
Bombay	..1,27,06,462	125,137
Sind	.. 3,87,972	4,187
Madras	.. 31,120	296
Burma	... 14,723	193
	1,32,60,277	131,313
Ground nuts —		
Bengal	.. 32	..
Bombay	..5,06,22,885	202,864
Sind	.. 22,497	104
Madras	14,28,51,987	584,241
Burma	.. 1,87,741	1,198
	19,36,85,142	788,407
Linseed—		
Bengal	..1,56,79,421	77,002
Bombay	..1,73,90,403	79,741
	3,30,69,824	156,743
Mahua seed—		
Bombay	.. 11,00,579	6,982
Mustard seed—		
Bengal	.. 1,09,628	414
Bombay	.. 11,07,038	3,936
Sind	.. 20,353	107
Madras	.. 760	3
	12,37,779	4,460
Niger seed—		
Bengal	.. 280	1
Bombay	.. 5,53,453	2,568
Madras	.. 1,71,800	879
	7,25,533	3,448

	Value. Rs.	Weight. Tons.
Poppy seed—		
Bengal	13,849	35
Bombay	1,94,583	546
Sind	20	..
	2,08,452	581
Rape seed—		
Bombay	1,59,382	760
Bengal	18,64,651	8,166
Sind	1,46,48,617	68,570
	1,66,72,650	77,496
Til seed—		
Bengal	6,175	49
Bombay	78,15,282	29,137
Sind	3,05,723	1,091
Madras	51,045	206
	81,78,225	30,483
Tea seed—		
Bengal	5,79,815	277
Bombay	2,47,982	62
Madras	1,485	..
	8,29,282	339
Other oil seeds not classified—		
Bengal	3,969	33
Bombay	69.146	453
Sind	30	..
Madras	23,651	135
Burma	22	..
	96,818	621
Total export of oil seeds	29,37,01,677	1,322,440
Total exported to British Empire	5,18,36,494	291,663
Other countries	24,18,65,183	1,030,777

APPENDIX V.

Export of vegetable oils—(1928-29).

	Value.	
	Rs.	Gallons.
Castor oil—		
Bengal	3,18,620	151,695
Bombay	5,81,886	235,608
Madras	3,13,514	151,149
Burma	500	200
	12,14,520	538,652=2,224 tons.
Coconut—		
Bengal	664	208
Bombay	28,010	7,762
Sind	6,499	2,287
Madras	1,86,018	78,002
	2,21,191	88,259=364 tons.
Cotton seed—		
Sind	180	50
Burma	10	5
	190	55=408 lbs.
Ground nut—		
Bengal	8,205	4,207
Bombay	7,28,157	342,646
Sind	13,050	6,273
Madras	1,09,035	57,314
Burma	59,173	29,997
	9;17,620	440,437=1,818 tons.
Linseed—		
Bengal	1,16,372	46,326
Bombay	1,425	631
Madras	320	120
	1,18,117	47,077=194 tons.
Mustard—		
Bengal	6,67,911	264,738
Bombay	10,250	2,911
Sind	4,824	1,998
	6,82,985	269,647 or1,113 tons
Til—		
Bengal	1,645	579
Bombay	4,19,692	140,894
Sind	64,722	23,230
Madras	40,003	14,771
	5,26,062	179,474=741 tons.
Others not classified—		
Bengal	17,950	1,849
Bombay	565	173
Sind	1,400	248
Madras	44,203	20,670
	64,118	22,940=94 tons.

	Value.	Weight.	Maunds.
	Rs.	Gallons.	
Vegetable oil total exports	37,44,803	1,586,541	178,969

Average price per maund Rs. 20-14-3.

These exports of oils were made as below :

	Value.	Gallons.	
	Rs.		
Total to British Empire	31,57,324	1,354,437	
Total to foreign countries	5,87,479	232,104	
	37,44,803	1,586,541	=6,551 tons.

APPENDIX VI.

Export of oil cakes—(1928-29).

	Value.	Weight.
	Rs.	Tons.
Castor cake—		
Bengal	26,348	352
Bombay	109,055	814
Madras	3,783	46
	139,186	1,212
Coconut cake —		
Bombay	52,500	292
Sind	3,17,036	2,290
Madras	2,33,743	2,113
	6,03,279	4,695
Cotton cake—		
Bombay	82,230	626
Madras	43,309	393
Burma	2,91,525	3,110
	4,17,064	4,129
Ground nut cake—		
Bengal	1,91,188	1,914
Bombay	1,16,29,539	85,881
Sind	345	1
Madras	25,55,361	24,300
Burma	43,62,156	51,066
	1,87,38,589	163,162
Linseed cake—		
Bengal	48,82,308	39,445
Bombay	61,29,967	47,192
	1,10,12,275	86,637
Rape and mustard—		
Bengal	39,02,910	40,965
Bombay	1,57,059	1,155
Sind	4,000	14
Madras	23,80,514	17,206
	64,44,483	59,340
Other oil cakes not classified—		
Bengal	1,99,767	1,911
Bombay	8,21,187	6,093
Madras	42,119	399
	10,63,073	8,403
Oil cake, total exports	3,84,17,949	327,578

Oil cake available in India as cattle food.

	Tons.
Total oil cake produced in India	2,412,168
Deduct oil cake export	327,578
	2,084,590

This amount divided over 51½ million milk-producing cows and buffaloes give 47·9 lbs. per head per annum.

APPENDIX VII.

Imports of vegetable oils—(1928-29).

	Value.	Weight.
	Rs.	Gallons.
Coconut oil—		
British Empire	55,11,079	2,393,309
Other countries	286	83
	55,11,365	2,393,392=9,883 tons
Ground nut oil—		
British Empire	10,662	5,768
Other countries	30	8
	10,692	5,776=23 tons.
Linseed oil—		
British Empire	7,92,097	231,224
Other countries	19,841	5,177
	8,11,938	236,401=976 tons.
Other vegetable oils not classified—		
British Empire ..	66,371	22,998
Other countries ..	2,12,915	74,649
	2,79,286	97,647=403 tons.
Total import of vegetable oils—		
British Empire ..	63,80,209	2,653,299
Other countries ..	2,33,072	79,917
	65,13,281	2,733,216=11,285 tons

Average price per maund Rs. 82-5-11.

APPENDIX VIII.

Imports of vegetable oil products—(1928-29).

	Value.	Weight.
	Rs.	Cwt.
Soap.		
In bars or tablets for household and laundry—		
British Empire	.. 96,42,434	316,587
Other countries	.. 5,62,601	25,756
	1,02,05,035	342,343=17,117 tons
Toilet soap—		
British Empire	.. 38,84,484	36,474
Other countries	.. 10,98,819	11,227
	49,83,303	47,701=1,385 tons.
Other soaps not classified—		
British Empire .	.. 5,07,307	13,793
Other countries .	.. 1,14,380	2,048
	6,21,687	15,841=792 tons.
Total imports of soap—		
British Empire	.. 1,40,34,225	336,854
Other countries	.. 17,75,800	39,031
	1,58,10,025	405,885=20,194 tons.
Vegetable oils refined and hydrogenated—		
British Empire	.. 93,164	2,179
Other countries	.. 1,76,34,188	456,095
	1,77,27,352	458,184=22,909 tons.
Total imports of vegetable oils and vegetable oil—		
Products	.. 5,58,60,638	73,682

APPENDIX IX.

Vegetable oil available in India for food, lubrication and other manufacturing purposes.

	Weight in tons.
Oil crushed in India	1,250,000
Less oil exported	6,551
	1,243,449
Vegetable oil imported	34,194
Total available	1,277,643
Average available per head of population	8,99 lbs per annum.

Provinces has been exceedingly hard hit due to large importation of ground nut oil. The existing charge for carrying the ground nuts does not permit the United Provinces Oil Mills to import seed and crush it with profit. The freight on ground nuts should be at the same rate as the freight on such things as mahua or castor seed.

In view to developing the mining and manufacturing industries and getting coal used all over the country in place of cowdung it might be worth while considering carrying coal on the railways at lower rates or even at a loss—the loss would largely be made up in extra freights which would come in due course from the increased manufacturing industries.

APPENDIX XI.

(a) *Sea freights.*

The rates charged by the British Steam Navigation Co. for 1927—1928—1929 are as under :—

	Oil.	Oil seed.	Oil cakes.
Bombay to South African Ports.	Rs. 36 per ton 20 cwt.	Rs. 2-2-0 per cwt.= Rs. 42-8 per ton.	Rs. 2-2-0 per cwt.= Rs. 42-8 per ton.
Calcutta to Australian Main Ports.	65 shillings per ton of 50 cubic feet.	25 shillings per ton of 20 cwt.	25 shillings per ton of 20 cwt.

Hall and City Lines, Ltd.

	Oil.	Oil seeds.	Oil cakes.
Bombay to Liverpool —			
1927	35 shillings per ton	19 shillings per ton	19/6 shillings per ton.
1928	35 „	16/6 „	17 „
1929	30 „	17 „	17/6 „
1930	30 „	18 „	18/6 „

	Lubricating oil in drums.	Paint.	Soap in cases.
Liverpool to Bombay—			
1927	50 shillings per ton	60 shillings per ton	50 shillings per ton.
1928	65 „	60 „	50 „
1929	60 „	60 „	50 „
1930	60	60	50

(b) *Railway freights.*

The question of existing railway freights for vegetable oil, and oil cake requires to be very carefully examined to see whether it would not be possible to reduce freights for these two commodities with a view to assisting and increasing the industry. The present rates for oil appear to be very high as compared to the freight charged for oil seeds, and if oil be forwarded at railway risk the rates are almost prohibitive.

There is a considerable difference in the rates charged per mile on the different railway systems, and in the interest of the industry it is particularly desirable that rates per mile should be standardized all over the country.

Under existing conditions there is a distinct advantage in sending oil seeds to the ports rather than sending oil, and oil cake. The railways do not appear to have done anything to encourage a heavy freight in cake other than to the ports.

The rate of freight on groundnuts appears to be unreasonably high from such places as Bombay Presidency to the United Provinces in consequence of which the oil mill industry in the United

Power plant for soap and paint plant.

	Cost. Rs. a. p.
One Crompton Parkinson 20 H.P. Motor and Starto	995 11 0
Shafting, Bearings and Pulleys	319 14 0
Belting	380 9 0
Steam and Water Pipes and Valves	42 2 3
	1,738 4 3

Summary of expenditure.

Oil Seed crushing Plants ..	35,815 1 3
Soap and Paint Plants ..	10,965 4 3
	46,780 5 6

APPENDIX XII.

Existing machinery in Oil Department, H. B. Technological Institute, Cawnpore.

	Cost. Rs. a. p.
Experimental Oil Mill.	
One set 4 High Anglo-American Rolls 6″ × 12″	6,687 0 0
One Seed Cooking Kettle	
One Hydraulic Pump	
One Hydraulic Press	
Capacity 2 cwt. seed per hour.	
Commercial Scale Oil Mill.	
One Marshall's Semi Portable 45 H. P. Engine and Boiler	8,151 10 0
One Rotary Seed Cleaning Machine	379 0 0
Four Seed Elevators	500 0 0
Two Meal Conveyors	100 0 0
One Christee and Norris Disintegrator	621 0 0
One Set Five High Anglo-American Rolls 16″ × 30″	5,900 0 0
One Pair Castor seed Rolls	300 0 0
One Krupp Oil Expeller with spare Shaft and Tools	6,227 0 0
Oil Pumps one steam driven, one belt driven	495 0 0
Tanks and resevoirs for oil	1,001 8 0
One 30″ Bottom discharge Centrifugal Machine	1,790 0 0
Two Weighing Machines	584 4 0
Shafting, Pulleys and Bearings	1,284 12 0
Piping and Valves for Steam, Oil, Water	656 3 3
Belting	1,137 12 0
	29,128 1 3

The capacity of this plant is 50 maunds of seed per 10 hours.

Soap plant.	
One Soap Boiling Pan capacity 1½ tons per charge	435 0 0
Soap Frames	
Crutching Pans	
Soap Chipping Machines	4,538 0 0
Soap Rolling Mill	
Soap Plodder	
Soap Stamping Machine	
	4,937 0 0
Colour grinding and paint mixing plant.	
One Set Edge Runner Stones	4,254 0 0
One Set Triple Rolls	
One Set Micro Twin Rolls	
One Paste Paint Mixer	
2 Paint Mixers	
One Cone Mill	

APPENDIX XIII.

Estimated cost of plant for the Oil Department, which has to be added to equipment.

		Rs.
1 Seed Cleaning Machine	..	2,60
1 Seed grading and separation	..	2,60
2 Solvent Extraction Plant	..	13,00
1 Anglo-American Press	..	1,300
1 Cage Press ..	..	3,000
1 Reduction Rolls ..	..	8,000
1 Hydraulic Accumulators	..	2,600
1 Hydraulic Pump ..	..	1,700
3 Fatty Acid Plant ..	..	6,500
3 Glycerine Recovery Plant	..	13,000
3 Glycerine Refining Plant	..	3,000
1 Oil Boiling Plant ..	..	2,000
1 Oil Refining Plant ..	..	3,000
1 Oil Deodorising Plant	..	13,000
3 Hydrogenation Plant	..	5,000
1 Decorticating Plant	..	3,000
Total	..	83,300
Power Plant for above ..	..	25,000
Total	..	1,08,300

The above prices are only estimates and are probably on the high side.

Place.	Variety.	Moisture per cent. on kernels.
Dhulia Farm	Virginia	3·77
	Big Japan	2·67
	Small Japan	2·36
	Dhulia, local	1·83
	Senegal	2·14
	Spanish peanut	2·89
Surat Farm—		
Unirrigated	Big Japan	1·67
	Small Japan	1·46
	Spanish peanut	1·76
	Senegal	2·18
	Mozambique	1·93
Irrigated	Big Japan	1·73
	Small Japan	1·43
	Spanish peanut	2·43
	Senegal	1·78
	Mozambique	2·01
Dhulia Farm	Big Japan	2·07
	Khandesh	2·64
	Nagpore, local	2·49
	Virginia, local	1·92
Chikodi (Belgaum)	Local	2·72
	Spanish peanut	2·11
Khed (Poona)	Local	2·42
	Spanish peanut	3·07

APPEXDIX XIV.

Extract from a note on the exhaustion of Indian soils and the methods by which this may be remedied, by R. V. NORRIS, D.Cs., *Agricultural Chemist, Madras.*

Let us consider first of all the nitrogen question. Nitrogen, like other plant food, exists in the soil in available and non-available forms, the most available form, nitrates, being produced from complex nitrogenous compounds in the soil, by a series of changes terminating in nitrification. Sometimes, however, these changes take another course, and in this way an accumulation of relatively unavailable nitrogenous material may take place, of which a familiar example is the production of peat. By cultivation we produce conditions, however, which are favourable to nitrification. One result, therefore, of the intensive cultivation to which I have already referred, will be to accelerate this conversion of unavailable nitrogenous material into nitrates, and unless appropriate measures are taken the reserves being used up at a rapid rate, exhaustion will occur. Such cultivation, moreover, has another disadvantage. It is well known that under suitable conditions very large quantities of nitrogen can be added to the soil from the atmosphere by the agency of nitrogen assimilating bacteria. But these bacteria require the presence in the soil of considerable amounts of carbonaceous organic matter. Hence if by our intense cultivation we use up at a rapid pace this organic matter in the soil, we shall thereby at the same time diminish this valuable fixation of nitrogen.

It is obvious, therefore, that we must combine such methods of cultivation with liberal supply of manure, and for the reasons I have stated, bulky organic manures, such as farmyard manure, poonacs and fish manures, are peculiarly suitable to the conditions prevailing in this country. Such manures, moreover, have a further advantage as compared with more concentrated manures in that they improve, to a marked degree, the mechanical condition of the soil, whereas the concentrated chemical manures have a tendency in the opposite direction.

Fish manure containing as it does a good percentage of both nitrogen and phosphate, is particularly suitable to our soils and yet the export is increasing rapidly. In February of this year Colombo was paying Rs. 160 per ton for fish gunao and consequently was attracting the bulk of this commodity which a year or so before was obtainable at Rs. 45 a ton ex-factory. This export is likely to continue, therefore, with a consequent increase in price in spite of the fact that the production of fish manure is necessarily limited and quite insufficient to meet the manurial requirements of the country.

OIL CAKE.

When we come to consider the case of oil cake we find again exactly the same conditions prevailing. These cakes, though they contain sometimes a fair amount of phosphate, must be regarded

chiefly as nitrogenous manure. Now the oil seed crops are notoriously exhausting to the soil. But if the seeds were crushed, and the resulting cake either applied to the land directly, or in the form of cattle manure after feeding, there would be at least some return of plant food to the soil. But the tendency is all the other way. Not only has the export of oil seeds steadily increased, but even in those cases where the seeds have been crushed in this country a large amount of cake is exported. The figures are instructive. Taking the normal years immediately preceding the War, the export figures for the whole of India were approximately as follows :—

1913-14 *All India*—	*Tons.*	*Value.* £	
Whole Oil seeds .	1,572,792	17,000,000	
Oil Cakes.. .	175,000	1,000,000	
From Madras alone—			
Oil Seeds..		3,500,000	
Oil Cakes..		400,000	(approximately).

This naturally led to a great increase in cost and the state of affairs is likely to become worse, owing to the intense demand for such products at the present time in European countries. Hence it is not surprising to find that the present price of groundnut cake is about Rs. 140 per ton, or three times the price for which it could be obtained a very few years ago. It is impossible for the average ryot to pay such prices, and it is in my opinion essential that steps should be taken to remedy this state of affairs. It would, therefore, appear necessary to prohibit entirely the export of fish manure of which the supply is so limited, and to impose an export tax on oil cakes, in order to retain a large quantity of these in the country. With regard to whole oil seeds also, a heavy export tax should be imposed. In this way the oil crushing industry could be developed in India, the oil being freely exported but the residual cake being consumed as far as required in this country. Two causes have hitherto tended to retard the development of oil crushing in this country. The fact was that when oil crushing was introduced, owing to the wholesale adulteration which took place, Indian oils obtained a thoroughly bad reputation. Secondly, European countries have imposed an import duty on oil, while allowing free entry to whole seeds and cake. The remedy for the first is obvious; in regard to the second, the conditions in Europe are such that it is doubtful whether these duties would be maintained if the supply of whole seed were restricted. Hence the time is now particularly favourable for such a change.

APPENDIX XV.

Note on the conservation of natural sources of manure by J. A. H. DUKE.

By a proposal to levy a tax on the export of oil seeds, oil cakes, bones, bone-meal, fish manure, or by the total prohibition of such exports, so far as the oil industry is concerned, I can only look upon such proposed legislations as being brought forward by persons without intimate connection with the oil industry from the business point of view. If an export tax be put on oil seeds, it means that the overseas consumer will seek other sources of supply at lower prices. The only Indian oil seeds on which a tax may be levied without dislocation of trade would be mustard or rape seed, and castor seed. It must be borne in mind that there are considerable quantities of castor seed grown in America and Australia, therefore if Indian seed is higher in price than that from other places the tendency will be for buyers to place their orders in countries other than India. In consequence of there being a shortage of buyers in India, due to the export market being temporarily closed, there will be a slump in the price of oil seeds in India, which fall will bring prices down at least equivalent to the amount of the export tax. This means that the dealer will still continue to make his usual profit and that the tax will in fact be paid by the cultivator, who presumably is the man whom Government wants to help. It will be quite impossible for the oil mills of India, as equipped at present, to deal with the whole of the seed which is thus thrown on the market. The mills are not equipped with sufficiently good plant for dealing with seed efficiently, and there are few mills in the country which are capable of making an oil fit for export. Therefore the crushing of this surplus seed in India is at present out of the question. India cannot absorb more oil than it does at present, since her population cannot afford to pay for more. For obvious reasons she is unable to export more than the quantities which are at present sent out of the country.

If it be necessary to levy a tax it should be in the form of a small cess per ton exported.

OIL CAKE.

If an export tax be levied on oil cake, it would probably entirely prevent, or at least limit the exportation of oil cake. This will react first on the oil millers, secondly on the agriculturalist, as the Indian oil millers will have to buy his seed at very much lower rates in order to hold large quantities of oil cakes in stock. If the oil millers are unable to sell cake readily in overseas markets the price of seed must either be lowered or the price of oil must be raised. The price of oil cake must then be lowered in order to find a market in India. Such a tax would entirely close down many mills which are at present crushing linseed, groundnut, castor seed, copra, and mustard. The present total exports of linseed cake amount to over 88,000 tons per annum. This cake

has recently been sold at Rs. 4 per maund, at that price the Indian agriculturalist will not buy it for feeding cattle. The same thing will apply to many mills crushing rape seed of which there are almost 60,000 tons exported annually.

Other exports of oil cakes are :—

Groundnut cake	163,162	tons.
Linseed	88,000	,,
Castor cake	1,212	,,
Coconut cake..	4,699	,,
Cotton cake	4,129	,,
Rape and Mustard	59,340	,,
Other cakes	8,403	,,

It seems rather surprising that the question of using oil cakes as manure except those unfitted for use as cattle food, should have been placed before the Royal Commission.

The only oil cake which is made in quantity at present and which is suitable for manure, is castor cake, since it is poisonous to cattle the other oil cakes are mostly good cattle foods, some are fitted for human food. To consider using cattle feeding stuff as manure, is considering further outrageous waste. If there is to be any serious attempt made in conserving manures in India, the first perhaps should be to prohibit the burning of cowdung, secondly, there should be intense propaganda in the villages by means of lectures, and pamphlets, on the subject of feeding cattle for milk production, and for draught purposes. A series of properly balanced rations, for these purposes, could quite easily be worked out by the Agricultural Chemists of the various provinces, giving a series of alternative diets, which would give increased milk production, and also a change of diet for the draught cattle. If this were done the cattle, both for draught and milk purposes, could be vastly improved, there would be immense quantities of cowdung of far better manurial value than it is to-day and the agriculturalist would find that his cows were very much more profitable than he ever imagined. I am of the opinion that if a tax is placed on oil cakes it would not only cause serious trade dislocation but would cause a large number of the small mills in India to completely close up, and this would react on the seed dealers, their clerks, and assistants, and upon the agriculturalist. In the following year the agriculturalist would most certainly reduce the amount of the oil seeds sown. Such an action would in the third year cause a very great rise in the price of oil, and oil cake, thus hitting the small man, who with his family is a consumer of oil, as a food stuff. This again would put oil cake quite out of the running, either as a cattle food, or as a manure, on account of its high price. It seems that if the agriculturalist could be induced to conserve the natural fertilisers, and place them on the land, there could be produced in India far more seeds than there are to-day. This would enable the agriculturalist to make greater profit than he does, it would also reduce the cost of the seed, which would, in turn, reduce the cost of oil and oil cake. It may be noted that, in Europe the only oil cakes which are ever utilised as manures are castor cakes, and occasionally a little rape cake. If there

is a serious attempt to make, or to induce, the farmer to feed his cattle better, and manure his land, then at the same time an organised attempt might be made to induce the oil miller to use more efficient machinery, and methods. If this were done probably 2 to 4 per cent. more oil could be produced from the existing seeds, and ratio of food units in the oil cake would be proportionately increased. In this connection the Agricultural departments all over the country might induce the agriculturalist to thoroughly clean his seed, instead of marketting it in a very impure state containing sand, straw, kankar, etc. The object of not cleaning the seed has in the past been due to the wish to obtain rather greater weight for sale. This in reality has hit the agriculturalist. Buyers make due allowance for the amount of foreign matter present in the seed, and large exporters have had to erect large seed cleaning appliances in the ports. Exporters cannot obtain more than market price for this seed, consequently they take the cost of maintenance and running this plant out of the pockets of the agriculturalist, plus cost of a large staff, engaged in running it, as well as the freight on 5 to 15 per cent. of dirt, etc. If it should be proposed to place more than a very small duty on an article such as copra, it would probably mean that the large European buyers, who are mostly confined nowadays to edible oil manufacturers, would purchase copra from the many other sources which exist, or they would confine themselves to the purchase of seeds giving similar oils such as palm kernels, from West Africa and similar seeds from the almost untapped supplies of the Amazon. The duty on the export of copra or coconut oil would tend to favour European manufacturers of Hydrogenated oils, as they are able by that process to convert liquid vegetable oils into solid ones. The duty on copra requires very careful consideration. It must be realised that, although India is a very large producer of oil seeds, there are many other countries which can supply the export market, equally well, if not better than India. Therefore, if the present sources of supply are interfered with by a duty it will be difficult, on some future date, to try to recover the lost trade. It might be well to consider the difficulties experienced by producers of copra, during the War and after. When the ordinary business had been upset by shortage of freight, many English mills then, for the first time, started to crush palm kernels for the edible oil trade, many have continued to do this in place of using copra. India's millions are at present in such a state of poverty, due very largely to ignorance, that they are unable to purchase sufficient food, but were steps taken to see that nature's supply of manure be kept for the purpose it was intended for, then not only would the agriculturalist, his animals and land be properly fed, but also the consumption of oil, and oil cake, in India would be very much greater than it is to-day. The export business of oil seeds would probably be even larger than it is at present. The proposal to tax the export of oil, and oil cake, is somewhat similar to that of a manufacturer reducing his output of manufactured goods in order to reduce his overhead charges and cost of production.

The oil industry could be considerably assisted, if Government undertook propaganda work on the utilisation of oil cakes, as feeding stuff, for milch cattle. This work might be considerably assisted by feeding demonstrations of three months' duration, in the leading market places, and at melas, etc. The publications of simply worded pamphlets in Hindi, Urdu etc., on how to feed a cow, or buffalo, in order to improve the yield of milk.

If the whole of the oil seeds, grown in India, were crushed and consumed here, there would still be insufficient oil cake for the existing milch cattle.

Bone-meal.—For certain crops bone-meal is an excellent slow acting fertiliser, the difficulty up to the present is that it is often difficult to get this material handled on the Railway, and it is even more difficult to get it handled and used by the agriculturalist.

Fish-meal.—The handling and using difficulties will continue to rise, until the existing prejudice dies out. Fish-meal is prized as a manure in other countries. There should be no difficulty in setting up profitable factories for the manufacture of fish oil, fish meal and dried fish, for human consumption. Such factories could be started at any part of the sea coast where there are fishermen and fishing equipment. It would probably be necessary to have steam trawlers run in conjunction with any such factory.

Fish-meal is not used at all by the Agricultural department, United Provinces, and bone-meal is only used in very limited quantities. Both of these meals are excellent manures for certain purposes, but there is difficulty in getting them used, or even handled. Fish meal would probably come out rather expensive, as the freight will have to be paid from South India, or the fish meal factory on the coast and this would possibly put fish meal out of the market for up country stations.

APPENDIX XVI.

Notes on methods of harvesting groundnuts in parts of South India by J. A. H. DUKE.

It occurred to the author of this note that much of the trouble caused to shippers of groundnuts, from parts of South India, through complaints regarding the high acid value of the oil, might be due to the methods of harvesting the seed after rain, or through the puddling process or to the system of wetting the seed prior to the decorticating process. These processes may start a partial germination of the seed, which set up actions within the seed, thereby causing hydrolysis to commence. From evidence given by Mr. Jasper Knight, Director of Messrs. Jurgens, Ltd., to the Royal Commission on Agriculture, it appears that the highest percentage of free fatty acid is found in Coromandel groundnuts, the percentage in the oil being 5·13 against 3·92 of the Bombay nuts, and 1·64 of Chinese shipments.

An investigation into the matter was made by the Indian Trade Commissioner, through the Empire Marketting Board, and the Director of Agriculture, Madras. From analyses made of standard samples of shipments of groundnuts, which are deposited with the Indian Oil Seeds Association, the following results were obtained from seeds shipped in December and January 1927. In some districts where rain falls during the harvest and shelling process seed is often damaged when standing in the open awaiting shipment.

Coromandel machine-shelled groundnuts.

Port of shimpment.	December 1927 % F. F. A. of oil.		January 1927 % F. F. A. of oil.	
	Average.	Highest.	Average.	Highest.
1. Vizagapatam	2·55	2·86	3·0	3·2
2. Bimlipatam	1·7	3·16	..	..
3. Coconada	0·98	1·0	..	..
4. Madras	4·21	9·06	4·13	10·2
5. Pondicherry	2·52	3·82	4·10	8·7
6. Negapatam	..	..	8·44	11·6
7. Calicut	7·94	12·25	5·0	6·5
8. Marmagoa	1·83	2·22	1·42	2·6
9. Bombay	1·32	2·26	1·55	2·2
Bombay groundnuts.				
10. Bombay	0·83	1·77	1·33	3·0
Khandesh groundnuts.				
11. Marmagoa	2·25	3·09	1·77	1·9

Messrs. Volkart Brothers, Bombay, who until recently were large shippers of groundnuts, have given the following information on the subject :—

(*a*) Districts, where groundnuts are harvested dry, and without rain, during harvesting—
Khandesh (Barars).
Bombay (Deccan).
Hyderabad.
Konkan (Satara Kolhapur).
Part of Madras (Deccan).
Part of Guntur District.

(*b*) Districts where there is rain or local showers during harvesting—
Vizianagram.
Pollachi (Coimbatore).
Mysore (Darangiri).
Tanjore.
Part of Guntur District.
Part of Madras (Deccan) near Madras Station.

(*c*) Districts where harvesting is done by irrigation, or puddling process—
North and South Arcot (exported through Pondicherry, Cuddalore and Porto Novo).

Messrs. Volkart Brothers, Bombay, state : " It is certain that the so-called Natal variety usually suffers most, as it cannot stand excessive moisture, as well as the Mauritins quality.

The Natal variety is harvested at the height of N. E. monsoon or 1-1½ months earlier than Mauritins."

In North and South Arcot there are two grades shipped—
(1) Ordinary or water-shelled.
(2) Machine-shelled.

The water-shelled quality is undoubtedly harvested by irrigation and marketted in a wet state. Machine-shelled quality are harvested dry, but are usually watered in the shelling factories to facilitate the shelling process. " The shelling process, by means of watering the nuts is a bad practice and has unfortunately gained ground in other districts also, mainly on the Madras Deccan. The object of the middlemen in doing this is, of course, in the first place, to gain weight. They overlook that by doing so the quality of the nuts is spoiled."

From the above table of analyses it is found that the nuts shipped from Bombay are distinctly of lower acid value than the others where rain, the puddling process, or water-shelling affects the nuts.

The Natal variety, regarding which Messrs. Volkart complain, are shipped from the ports of Marmagoa and Calicut, Pondicherry, Negapatam, and Madras. The average percentage of free fatty acid in the oil contained in the nuts shipped from these 5 ports is 4·4% against 1·44% of the Bombay shipments. The matter requires to be closely investigated, to ascertain the precise reason for the high acid value.

It may also be noted that on the Bombay side shippers have greater control of the marketting and shelling conditions, as some of them own factories where the shelling process is conducted.

There has been considerable work done by the Agricultural Chemist to Government, Bombay, in regard to the percentage of moisture contained in the various varieties of groundnuts grown by the Agricultural department, including crops with and without irrigation. Those grown without irrigation contained moisture varying between 1·61% (Barbados) and 5·48 (Spanish variety), whilst those grown as an irrigated crop, varied between 2·08 and 7·08 percentage of moisture in the kernels.

There does not appear to have been any work done on the question of moisture in the nuts, and acid value of the oil, from crops harvested by either dry or irrigated methods.

GROUNDNUTS.

The moisture content of the kernels.

Figures supplied by the Agricultural Chemist to Government, Poona.

Place.	Variety.	Moisture per cent. on kernels.
Dharwar Farm—		
As dry crops	Big Japan	2·84
	Pondicherry	2·77
	Spanish peanut	..
	2nd germination	2·89
	Spanish peanut, new	2·59
	Surat, local	3·11
	Senegal, old	3·11
	Senegal, new	2·40
	Egyptian	2·42
	Virginia	3·39
	Small Japan	2·83
	Mozambique	3·01
	Chinese No. 1	2·33
	Chinese No. 2	3·49
	Brazil	3·63
	Barbados	1·61
	Mauritius	2·47
Surat Farm	Small Japan	3·27
	Spanish peanut	3·42
	Big Japan	3·45
	Pondicherry	2·95
	Virginia	3·14
	Surat, local	3·42
	Mozambique	3·80
	Egyptian	3·21
	Mauritius	3·72
	Senegal	3·54
	Chinese No. 1	2·66
	Chinese No. 2	3·59
	East Africa	4·26
	Barbados	2·31
Dhulia Farm	Big Japan	4·35
	Virginia	4·20
	Dhulia, local	4·39
	Mozambique	4·03
	Spanish variety	5·48

Place.	Variety.	Moisture per cent. on kernels.
Surat Farm—		
As irrigated crops ..	Spanish peanut	2·26
	Small Japan	3·46
	Big Japan M.	3·82
	Mozambique	3·24
	Senegal	3·87
	East Africa	5·28
	Egyptian	2·80
	Mauritius	3·68
	Virginia	3·48
	Pondicherry	3·32
	Chinese No. 1	3·03
	Chinese No. 2	3·31
	Surat, local	3·08
Dohad Farm	Big Japan	7·08
	Small Japan	6·20
	Virginia	6·18
	Mozambique	6·92
	Spanish peanut	5·92
	Pondicherry	6·28
	Senegal	6·73
Surat Farm	Spanish peanut	2·87
	Mozambique	3·78
	Senegal	4·63
	Big Japan	4·22
	Small Japan	4·52
Dharwar Farm	Big Japan	3·08
	Pondicherry	2·08
	Spanish peanut	2·28
	Surat, local	2·65
	Senegal	2·20
	Egyptian	2·43
	Virginia	2·12
	Japanese, small	2·19
	Mozambique	2·96
	Chinese No. 1	2·69
	Chinese No. 2	3·12
	Brazil	2·15
	Barbados	3·30
	Mauritius	2·81
	Tamboo	3·40
	Katjang	2·79
	Big Japan	3·57
	Pondicherry	3·55
	Senegal	2·89
	Egyptian	3·85
	Virginia	3·98
	Small Japan	4·42
	Chinese No. 2	4·16
	Spanish peanut, new seed	3·43
Dohad Farm	Spanish peanut	2·66
	Senegal	2·36
	Mozambique	2·38
	Virginia	2·47
	Small Japan	3·01
	Big Japan	3·07
	Pondicherry	3·26

If the number of trees per acre are taken at the lowest figure of 58 the following is the cost and yield calculated in rupees :—

	Rs.	a.	p.
Cost of first three years at 200 Dollars per acre	550	0	0
Interest on capital outlay at 7 per cent. for 10 years	385	0	0
	935	0	0
Yield in fourth year from 58 trees 8·5 lbs. nuts per tree=493 lbs. nuts. The kernels are 32·3 per cent. of the nuts or 155·2 lbs. =1·98 maunds at Rs. 6	11	8	0
Yield in fifth year 16 lbs. nuts per tree=928 lbs. =299·7 lbs. kernels at Rs. 6 per maund =3·6 maunds	21	6	0
Yield in sixth year 36 lbs. per tree =2,088 lbs. = 674 lbs. kernels at Rs. 6 per maund = 8·2 maunds	49	0	0
Yield in seventh year 52 lbs. per tree=3,016 lbs. =974 lbs. kernels at Rs. 6 per maund = 11·8 maunds	70	0	0
Yield in eighth year 60 lbs. per tree=3,480 lbs.= 1,124 lbs. kernels at Rs. 6 per maund =13·7 maunds	82	0	0
Yield in ninth year 63·5 lbs. per tree=3,683 lbs. =1,189 lbs. kernels at Rs. 6 per maund =14·5 maunds	87	0	0
Yield in tenth year 70 lbs. per tree =4,060 lbs. =1,311 lbs. kernels at Rs. 6 per maund=16 maunds	96	0	0
Total ..	416	14	0

Income equals over 7½ per cent. on the investment.

Labour in United States of America is considerably higher than in India, so that it is possible that cost of seedlings, ploughing, cultivating and watering could be considerably reduced if the work is undertaken in India.

If the figure given by the Conservator of Forests, Afforestation division, Cawnpore, be taken, the cost for 3 years would be reduced to Rs. 250 per acre including fencing and manuring.

APPENDIX XVII.

Indian weights and measures.

United Provinces—

Benares,	one seer	.. ..	=90 tolas.
Allahabad,	,,	.. ..	=100 ,,
Cawnpore,	,,	.. ..	=83 ,,
Jaunpur,	,,	.. ..	=112 ,,
Allahabad,	one maund	..	=4,000 ,,
Cawnpore,	,,	.. ..	=3,320 ,,
Jaunpur,	,,	.. ..	=4,480 ,,

In addition to the above there is a further variation of the standard maund of 82 2/7 lbs.

The cotton maund is 50 standard seers which is equal to 103 lbs.

5 tolas	=1 chhatak.
16 chhataks	=1 seer.
40 seers	=1 maund.

In some places there is a kachcha maund 16 seers.

For gold, drugs and valuable articles—

8 khaskhas (poppy seeds) ..	=1 chawal (grain of rice).
8 chawals	=1 ratti.*

(*Represented by a ghungchi the seed of Abrus Precatorious).

8 rattis	=1 masha.
12 mashas	=1 tola.

In some places the ratti is divided into 20 bisas and a tank of 24 rattis is used.

The seer is the basis of larger weights. The seer varies in weight and is of a varying number of tolas of 180 grains.

The Ghazipur seer is based on a tola of 216 grains. The seer of 80 tolas is used in Agra, Aligrah, Almora, Banda, Bulandshahr, Dehra Dun, Etah, Etawah, Jalaun, Jhansi, Meerut, Muttra, Muzaffarnagar.

The 80 tola seer is also used in the following places but side by side with numerous local seers :—

Allahabad, Benares, Cawnpore, Fatehpur, Hamirpur, Mirzapur, Sultanpur and Unao.

In Cawnpore there are a very large number of maunds for special commodities.

Table showing variations in the weights used in certain districts of the United Provinces.

District or tahsil.	Weights used.	Commodity.
District Cawnpore ..	Standard maund of 40 seers ..	Fruits, vegetables, sago, flour, castor oil, cotton seed, bark, hides, steel, iron plates, corrugated sheets, coal and coke, slaked hive, fine wool, and ghi.
Do. ditto ..	Maund of 41½ seers	Wheat, gram, rice, pulses, and peas.
Do. ditto ..	Ditto 41 „	Oil except castor oil.
Do. ditto ..	Ditto 41½ „	Oil seeds.
Do. ditto ..	Ditto 46 „	Cast and wrought iron pipes, iron sheets and hooping, copper, steel rods, tin when not in ingot form, sambhar salt, cloves and Gujrat cardamums, sugar, ginned cotton, hemp and jute twine, indigo cake, Lahori salt, saltpetre, zinc, betel nuts.
Do. ditto ..	Ditto 48¾ „	Tobacco for chewing, tobacco for smoking and molasses.
Do. ditto ..	Ditto $48\frac{5}{16}$ „	Tin ingots.
Do. ditto ..	Ditto 49 „	Resin.
Do. ditto ..	Ditto 50 „	Coarse wool, raw cotton, charcoal, dhania, Himalayan cardamums, turmeric, potatoes, paper waste, and indigo seed.
Do. ditto ..	Ditto 5 „	Figs.
Do. Dehra Dun	Ditto 60 „	Lime.
Do. ditto ..	Ditto 40 „ (standard) ..	For all other commodities.
Do. Saharanpur	1 seer= 86 rupees or tolas .. 1 maund=40 local seers ..	Nearly for all commodities.
Do. ditto ..	Standard seer of rupees 40 ..	For fruits.
Do. Moradabad	Seer of 100 tolas. Other weights are :—	
Do. ditto ..	1 saia=1¼ seers.	
Do. ditto ..	8 saias=1 bahni	For cane juice.
Do. Lucknow ..	Standard seer of 80 tolas and standard maund of 40 seers.	Nearly all products except spices and dry fruits.
Do. ditto ..	Maund of 40 seers of 100 tolas ..	For spices.
Do. ditto ..	Ditto 50 standard seers ..	For fruits.
Do. ditto ..	Ditto 46 „ „ ..	For sugar.
Do. ditto ..	Ditto 48 „ „ ..	For khoa.

District or tahsil.	Weights used.	Commodity.
District Mirzapur ..	Seer of 80 rupees.	
Tahsil Chunar (Ahraura).	Do. 92 „	
Tahsil Robertsganj	Do. 40 „ kachcha seer.	
Tahsil Mirzapur (hilly portions).	Do. 32 „	
Tahsil Mirzapur ..	The table is—	
	16¼ paos =1 dhara=Rs. 330	For grains.
	16 seers =1 maund kham ..	Ditto.
	1 seer =32 rupees ..	Ditto.
	Paila =1 seer=32 rupees	Ditto.
	Kurai =4 pailas or seers.	
	17 paos =1 dhara=340 rupees	For ghi.
	1 seer =79 rupees ..	For utensils.
	1 „ =80 „ ..	For iron and milk.
	Lagauri =33 dhara.	
	1 dhara =320 rupees ..	For salt and sugar.
	12½ dhara =1 maund.	
	1 dhar =320 tolas ..	For wood and fuel.
	1 tola =12 mashas=Re. 1-3-0	
	10½ mashas =1 rupee ..	For gold.
	1 bhari =1 „ ..	For silver.
District Gorakhpur tahsil Gorakhpur (rural areas).	Seer of 80 and 90 rupees.	
Gorakhpur (City) ..	Do. 80 rupees	For minerals.
Ditto ..	Do. 128 „	For tobacco, vegetables.
Ditto ..	Do. 144 „	For other grains.
Tahsil Maharajganj	1. Standard seer of 80 rupees.	
	2. 25 ganda seer of 90 „	
	3. 42 ganda rajia of 160 rupees ..	For grains.
	4. 37½ „ „ „ 150 „ ..	Ditto.
	5. Basi Saia of 100 rupees ..	For rice only.
	6. Small „ „ 90 „ ..	Ditto.
Do. Bansgaon ..	1. Seer of 100 rupees.	
	2. Standard of numbari seer of 80 rupees.	
	3. Saia 100 rupees.	
Do. Deoria ..	Seer of 50 and 80 rupees.	
Do. Padrauna ..	1. Seer of 104 rupees ..	For sugar.
	2. „ 40 „	For food stuffs.
	3. „ 80 „	For *Halwai* shop.
Do. *Hata*—		
In Hata Khas ..	Seer =100 rupees.	
	Rajia =150 „	
„ Captainganj ..	Seer = 30 and 32½ rupees.	
	Rajia =124 rupees.	
„ Ruddarpur ..	Seer =100 „	
	Saia =100. „	
„ Gauri Bazar ..	Seer = 92 „ ..	For grains only.
„ Rampur—		
Karkhana ..	Seer =100 and 52 rupees.	
	Rajia =168 rupees.	

District or tahsil.	Weights used.	Commodity.
District Allahabad ..	Pucca maund=53 seers and 5¼ chatanks.	
Do. Agra ..	Standard weight	For all commodities.
Do. Etawah 1	1 seer=100 tolas	For cotton, ghi and sugar.
	50 seers=1 maund	
Do. do. 2	1 seer=102 tolas	For hemp and tobacco.
	51 seers=1 maund	
Do. do. 3	1 seer=100 tolas	For commodities.
	40 seers=1 maund	
Do. do. 4	Standard weight	For all commodities.
Do. Farrukhabad	1 seer=110 tolas	For ghi and sugar.
	55 seers=1 maund	
	Standard weight	For all commodities.

Bombay.—The Bombay maund is 28 lbs. or 14 seers.

One khandi=20 maunds=280 seers.

One Bombay khandi=784 lbs.=392 seers.

In Eastern Khandesh district the maund has thirteen different values ranging from 21½ seers at Bodwad to 80 seers at Pachora. In Khandesh the khandi varies from 160 to 250 lbs.=80 to 125 seers.

The unit of 1 nag used in the south of the province=336 lbs.=168 seers.

Madras.—One Candy=500 lbs.=250 seers.

In the district where the cotton known as "Westerns" grow there is a unit of one nag which equals 312 lbs.=156 seers.

Punjab.—Six different measures are in use.

Burma.—Groundnuts are sold after being measured in condensed milk tins.

Improvement necessary in the system of weighing.

Throughout India the system of weighing grain and oil seeds needs special attention. In the various grain markets the system appears to consist chiefly of the agriculturalist bringing his cart to the market where the merchants engage official weighers who conduct the weighing on hand scales, which usually do not weigh more than 5 seers per operation.

Observation shows that this system is one which is open to abuse. The weights are usually one or two small metal weights, and the balance is made up of pieces of broken bricks—in the first place the weights are probably inaccurate. The weights are usually placed to

the right for half the operation and to the left for the second half, when the weigher raises his scale. The seed or grain is to the right or left, as the case may be, and in consequence the beam of the scale goes against the weigher's hand—he holds the scale by means of a piece of string from the centre, and in consequence there is a considerable leverage between the fingers and the heal of the hand. The weigher can, in consequence, weigh heavy or light.

In the weighing of a lakh of maunds of grain or oil seeds it necessitates no less than 8 lakhs of weighing operations, and if it be calculated that in each weighment of 5 seers there is a discrepancy of one ounce, there is a difference of 625 maunds—and if this be valued at Rs. 5 per maund, it means that in most cases from every lakh of maund of seed marketted by the agriculturalist, he is deliberately robbed of over 3,000 rupees.

This system exists all over India and is applicable to many articles other than grain and oil seeds.

This is one of the first matters which should receive attention if it is the intention of India to raise the status of agriculturalists.

In very few of the factories of India are there to be found such things as weigh-bridges or really accurate scales. There are practically no such things as public weigh-bridges on the main roads as exist in other countries.

The attention of Agriculture Co-operative Societies might be drawn to this matter, and it might be suggested to them in the interest of their members that they should erect a weigh-bridge at some central place where agriculturalists can get their carts weighed, and before taking goods to markets can place the cart and its contents on the weigh-bridge, and ascertain how much grain or oil seeds they are taking to market.

The attention of municipalities might be drawn to this matter and suggestions made to them for the good of the trading public that there might be municipal weigh-bridges erected and kept in the charge of a municipal officer who would affect weighments. This would enable the agriculturalist to have a very good check over the weighments which take place at sundry factories and shops where they deliver goods. Attention to this has beendrawn in the United Provinces Banking Enquiry Committee Report.

APPENDIX XVIII.

The prospects for developing the industry of cotton seed crushing in India.

Cotton seed is one of India's main oil seed crops, and is the largest of them with possibly the exception of groundnuts.

India produces annually 1½ million tons of cotton seed.

At present a negligible quantity is crushed for the production of oil and oil cake in India.

The following estimate shows how the crop of seed is utilised at present :—

	Tons.
Retained as seed	200,000
Exports of seed	130,000
Crushed in India	20,000
Seed fed to cattle	1,250,000

Three main factors have prevented the development of the cotton seed crushing business in India—

(1) There is little or no demand in India, for cotton seed cake, either decorticated or undecorticated qualities.

(2) There has been no satisfactory method for removing the short fuzz from Indian cotton seed.

(3) Cotton seed has been allowed to lie about in ginneries in a damp condition, which permits insects to attack the seed, with a consequent loss of oil, and the quality of oil is also seriously damaged through this careless storing of the seed.

Other reasons for the industry being left undeveloped, are due to extra capital outlay required to be made for auxilliary plant, for the preliminary preparation of the seed for satisfactory crushing.

The two oil mills which at present crush cotton seed, are forced to export some 4,000 tons of oil cake, which is the greater part of their output, as there is no demand for this valuable cattle food from the Indian agriculturalist.

The crude oil produced from cotton seed in India is not suitable for edible purposes until it has been carefully refined. The cost of refining plant is a further factor preventing existing mills from entering this business.

If the business is to be developed it will be necessary to insist upon the careful treatment of seed at the ginneries.

This would entail the drying of all seed, either on sun-drying platforms, or by steam-heated dryers.

The cost of the latter system for plant and fuel will raise the cost of the seed considerably above present prices.

An alternative method would be to utilise the machine invented by Mr. A. F. Yull, A.M.I., CHEM. E., and at present produced by His Exalted Highness the Nizam's Mint and Workshop, Hyderabad, or a similar invention.

This machine is capable of removing some 10 per cent. of fuzz and husk from Indian cotton seed, thereby producing the seed in a form in which it can be easily dried. It would be necessary to establish at least one or two of these machines at each ginnery, so that the daily output of seed can be defibrated, dried, bagged and at once despatched to the oil mills for crushing.

The industry should be developed along the lines of the American Cotton Seed Crushing Industry, which enables the bulk of the cotton seed to be crushed within a few months of being ginned.

If such methods were adopted in India, it is perhaps possible that many of the pests, which attack the Indian cotton crops, would be exterminated.

In the cotton districts where the ginneries exist, it might even be possible to establish a central refinery to treat all the oil from the mills producing cotton seed oil.

A scheme such as this might be successful, if it is possible to get the co-operation of all the mills which would undertake the crushing of cotton seed. This co-operation might be obtained if Government undertook to guarantee a fixed price for decorticated cotton seed cake, and at the same time propaganda work was commenced to persuade the agriculturalist that cotton seed cake was a better food for cattle than cotton seed. During the period that would be required to find a market for all the cotton seed cake that would be produced, it would not be difficult to find ready buyers for the bulk of the production outside India provided that the cake was carefully made and was up to the standard of the oil cake made in Europe or America.

The fuzz which would be removed in the process of defibration, would be suitable as a paper-making material if it was subjected to a cleaning process for removal of dust and particles of shell. This material would be saleable at a price which would possibly recover the cost of the defibration and drying processes.

The greatest difficulty to be overcome is undoubtedly that of persuading the Indian agriculturalist to use cotton cake. At present he is able to purchase cotton seed at prices ranging between Re. 1 and Re. 1-8 per maund, and he cannot understand how cotton seed cake at prices around Rs. 2 to Rs. 3 per maund is a cheaper and better food than the whole cotton seed.

It was this matter which defeated the efforts made by the United Provinces Government in 1912, when they set up an oil mill for cotton seed crushing.

In this case, however, there was no plant for decorticating the cotton seed, which was pressed as whole seed, giving a cake of very inferior quality, compared to that made from decorticated seed.

APPENDIX XIX.

PAPER FROM COTTON SEEDS.

Extract from Calcutta Commercial Gazette, dated July 20, 1931, *pages* 988-989.

Mr. A. F. Yull, A.M.I., in a letter to the editor of the *Times of India* says as follows :—

It is incumbent upon me to inform you that further experiments on a commercial scale with the "Hyderabad" cottonseed defibrating machine on various type of seeds yielded results which were not quite in accordance with those regarding which particulars were given in my report, and in consequence some of the conclusions arrived at in the report have had to be considerably revised and amended.

In the first place the percentage of crude fibre and dust obtained as a bye-product when defibrating certain common types of cotton seeds was found to be much higher, and the latter samples were found to contain a smaller percentage of actual fibre than the earlier.

This state of affairs naturally led to a reconsideration of the question of the suitability of the material in question for the manufacture of paper pulp. If the usual chemical methods of manufacture were to be followed, its higher requirements of chemicals and lower yield of actual fibre or paper pulp might well render its use for this purpose uneconomical, as compared with other raw materials which might be available in more favoured situations.

Fortunately it has been found possible to largely dispense with the chemical method of treatment and to use a cheaper biochemical method of manufacture, by means of which the very inpurities present in the raw material are utilized to feed the bacteria, which in turn set free the actual fibre from the mixture and make it suitable for use as a paper-making material.

Whether or not the more or less pure fibrous material resulting from the biochemical treatment will still require some modified chemical treatment remains to be seen, but in any case it may be taken for granted that the results anticipated in the Hyderabad State report can easily be equalled, if not excelled, by making use of this new biochemical process in conjunction with defibration.

The cotton seed crop of India, which amounts to about 2 million tons a year, if defibrated in accordance with the writer's suggestion is capable of supplying raw material sufficient for the production of not less, and probably considerably more, than 50,000 tons of writing and printing paper per annum, or alternately of providing all the paper pulp required by the Indian paper-making industry, and thus enabling the import of foreign-made wood pulp to be discontinued.

APPENDIX XX.

The cultivation of mahua trees, cost and income.

Mahua trees are not at present being planted to any extent with a view of producing income. The supplies of mahua seed and mahua flowers are at present collected from trees most of which are perhaps self sown, or from a comparatively few trees owned by district and municipal boards and planted by them on the roadsides.

There do not appear to be any definite records of the number of trees which exist, or the quantity of seed and flowers available annually.

The pre-war export of mahua seed was 33,000 tons, so that it is probable that 80,000 to 100,000 tons are available from a normal crop.

The crop usually fails once in three years.

The oil obtained from the seed is a valuable one, and is better adapted for the manufacture of hard bar soaps and toilet soaps than any other oil available in Northern India.

The cake is of little value as a manure being low in nitrogen ; it contains a small amount of potash. The present price is 3 annas per maund.

The flowers are used in various ways, such as food, raw material for distilleries and as cattle food.

The average yield per tree may be taken as under at ten years old, although the trees begin to bear from eight years onwards :—

Oil seed	.. ..	2 maunds.
Flowers	.. ..	3 ,,

The average prices for these products, over the past seven years 1924 to 1930 have been as under :—

	Rs.	a.	p.	
Mahua oil seeds.	4	8	0	per maund.
Mahua flowers	2	4	0	

The following figures of cost of cultivation of trees on canal banks have been supplied through the Chief Engineer, Public Works department, United Provinces:—

NARORA DIVISION, LOWER GANGES CANAL.

Cost per mile 75 to 100 feet wide.

Nursery work	Pay of beldar Rs. 10 for 1 acre per month. Water free. Yield 100 to 200 plants 3 feet high per year. *Cost Rs.* 120 per 100 to 200 plants.
Planting out	Annas 6 to 8 per tree, including cartage up to 10 miles and making thaolas. *Cost at 8 annas per tree.*
Maintenance	Rupees 10 per month per mile=Rs. 120 per annum with trees 25 to 30 feet apart in single row. Rupees 10 per annum for replacement of dead trees. Cost Rs. 130 per mile per annum

BULANDSHAHR DIVISION, GANGES CANAL.

(1,000 plants per mile).

		Rs.	a.	p.
1.	Collecting seeds and sowing in nursery after preparing a field for same.	10	0	0
2.	Upkeep of plants, transplanting in nursery and watering up to a period of two years.	50	0	0
3.	Removal of plants to canal bank and planting them, cartage to a maximum of 5 miles.	50	0	0
4.	Upkeep of 1,000 plants for four years	480	0	0
5.	Extra charges for miscellaneous expenditure ..	50	0	0
	Cost per 1,000 plants per mile	640	0	0

N. B.—Water free.

MEERUT DIVISION, GANGES CANAL.

		Cost per plant. Rs.	a.	p.
1.	Digging pit 2′ × 2′ × 2′, manuring after planting ..	0	2	0
2.	Cost of earth tree guard	0	14	0
3.	Planting out and weeding	0	2	0
4.	Cost of plants from canal nursery	0	4	0
5.	Maintenance for four years	1	8	0
	Cost per tree at four years	2	14	0

EXECUTIVE ENGINEER, CAWNPORE PROVINCIAL DIVISION.

		Cost per mile of double avenue of trees—264 trees per mile. Rs.	a.	p.
	First year.			
1.	Digging pits and manuring, making thelas, carriage of plants from nursery, wages of two malis, shading trees.	574	0	0
	Second year.			
2.	Wages, repair of thelas, replacement of dead trees, shading plants.	275	0	0
	Third year.			
3	Wages of one mali and repair of thelas	133	0	0
	Fourth year.			
4	Mali's wages	108	0	0
	Nursery expenses.			
	Cost of plants and cartage to nursery, manure and mali's wages ..	300	0	0
		1,390	0	0
	Total cost per tree at four years ..	5	4	3

Watt in his " Commercial Products of India " states that the flowers appear in March and April each year, each tree yielding two to four maunds.

Mukerji in Handbook Industries Agriculture 291 says the yield from each tree is five to eight maunds.

Nichols estimates that in Central Provinces the flowers are used as food by 1,400,000 persons each consuming about one maund per

year and that the value of the flowers is estimated at $1\frac{1}{4}$ million pounds sterling to the Central Provinces as food alone.

CONSERVATOR OF FORESTS, AFFORESTATION DIVISION, CAWNPORE.

	Cost of planting trees 40 feet × 40 feet per acre.
1. *First year.*	Rs. a. p.
Soil preparation, seed, sowing, weeding, pay of guard, uniform, hut and travelling allowance.	34 0 0
2. *Second year.*	
Weeding and pay of Forest guard	7 0 0
3. *Third year.*	
Pay of Forest guard	5 0 0
4. *Fourth year.*	
Pay of guard	5 0 0
Cost of 27 trees at four years	51 0 0
Cost per tree	1 14 3

From the estimates given above it is found that the cost of mahua trees, planted 40 × 40 in double lines on each side of a canal is between Rs. 336 and Rs. 2,780 per mile with 528 trees.

The cost is at the end of the fourth year when mahua trees should not require further attention.

The following estimate of cost and income are based on the highest of the above costs :—

Estimate of cost and income which could be derived from 1 *mile mahua trees planted* 528 *per mile after the eleventh year and onwards.*

500 mahua trees per mile after allowing for a total loss of 28 trees per mile.

Yield at the eleventh year.	Cost. Rs.	Income. Rs.
One maund seed per tree at Rs. 4 ..		2,000
One maund flowers per tree at Rs. 2 ..		1,000
Deduct—		
Cost of bringing trees to bearing state at eleven years	2,780	
Six per cent. interest on Rs. 2,780 for eleven years	1,834	
	4,614	3,000
Balance being nett loss per mile for eleven years		1,614
Twelfth year.		
Income and yield as above	3,000	
Deduct loss on eleventh year Rs. 1,614 .. .. } Six per cent. interest on Rs. 1,614 for one year Rs. 97 }	1,711	
Balance being nett profit at twelfth year	1,289	

If allowance be made for a total crop failure in each third year there should be an average profit of Rs. 2,000 per mile from the thirteenth year onwards up to the 50th year or more. When the trees cease to bear they would probably be worth Rs. 10 each as firewood.

APPENDIX XX (*a*).

Estimate of cost of cultivating tung oil trees (Aleurites Fordii).

The following figures have been taken from those prepared by Mr. H. A. Gardner, the Director of the American Paint Research Institute and Vice-President and General Manager of the American Tung Oil Corporation.

This concern was formed in the United States of America in 1923 when the importation to America of Chinese tung oil was around 40,000 tons per annum. The object of the company was not entirely as a money making concern, but to demonstrate to land-owners what could be done with tung oil trees as a crop. In 1927 when the capital of the concern was increased reference is made to the development made in the groves at Gainesville where a crop of fruit was obtained approximately 16 tons at 4 years growth.

According to Gardner the comparative yield of oil per acre from various crops is as under:—

	Maximum yield per acre.
Cotton seed	150 lbs.
Groundnuts	300 ,,
Linseed	255 ,,
Tung trees	400 ,,

He states that, in the case of tung trees, the yield may rise as high as 1,800 pounds in the ninth year of growth, based on 30 lbs. of oil per tree with 60 trees per acre.

In the figures given below, prepared by Mr. Gardner in January, 1924 to cover the first 3 years of the cost of cultivation, which on 1,000 acres cultivated cost 154 Dollars per acre.

The Corporation started in 1924 with 270 acres, and in 1926 had planted up 1,400 acres, as well as raising 500,000 seedlings, at which time the paid up capital of the Corporation was 87,600 Dollars. This shows that the original estimate was fairly correct.

No income was expected for 5 years, but it was anticipated that at 4 years there would be an income of 50 Dollars per acre, rising to 100 in fifth year and 200 Dollars at ten years.

Recent information, contained in Circular 336, American Paint Manufacturers Association (Gardner), regarding cost of cultivation shows that 200 Dollars per acre is a safe figure to cover cost of planting and carrying the plantations through with all necessary cultivation and fertiliser costs to the end of five years, which figure includes a sum of 50 Dollars for cost of land and clearing.

If the planting of tung oil trees could be tried on the canal banks of Northern India, and were found suitable for soil inclined to be damp, there should be a substantial income returned. The seed collection and transport could be cheaply undertaken if there were suitable small boats available on the canals.

It may even be possible that these trees would thrive in some of the ravine lands, in which case it would be possible to recover many thousands of acres of what is at present a barren waste.

Recent information from the United States of America show that even in bad years the American is not afraid of launching out on this project. There are already 8,000 acres planted up in Florida, and many concerns have been started with a view to the cultivation of tung oil trees, including one which will spend 10 million Dollars over 10 years in planting up 50,000 acres, and another intends to spend 5 million Dollars in planting up 20,000 acres.

Estimate of yield.

Age of tree in years.	Fruit in bushels per tree.	Number of trees per acre.	Weight of nuts per tree.	Weight of oil in lbs. per tree.	Value per acre at 15 cents. per lb for oil.
					Dollars.
4	·5	116	8·5	2·9	56
5	1·0	116	16·5	5·6	100
6	2·2	116	36·0	12·0	210
7	3·0	116	52·0	17·6	310
8	3·7	58	60·0	20·5	175
9	3·8	58	63·5	21·6	185
10	4·1	58	67·0	22·8	195
After 10	4·3	58	70·0	24·0	200

In China tung trees yield 1 to 5 bushels of fruit per season according to age.

The experiments in America show that from 1,000 lbs. of ruit there were obtained the following :—

Husk 640 lbs.	..	460 lbs. outer husk. 180 lbs. inner shell.
Kernels 360 lbs.	..	158 lbs. filtered oil. 165 lbs. oil cake.
		323 lbs.

In working this into oil and cake there were losses of 37lbs. due to cleaning and loss in weight, which is probably moisture. The kernels contain 48·8 per cent. oil.

The yield of oil in crushing is slightly over 43½ per cent. on the kernels.

The cake being 56·5 per cent.

The oil cake is of considerable value as a fertiliser on account of its nitrogen, phosphoric acid and potash contents.

The analysis of the cake is as under :—

Nitrogen equivalent to NH_2	..	6·4 to 4·2
Phosphoric acid ..		1·73 to 2·7
Equivalent to bone phosphate		3·78 to 5·9
Potash		1·28 to 1·2
Moisture		5·4 to 6·7

These figures have been confirmed in England by comparison with fruit from China. The total protein in the cake is 37·8 per cen

Cost per acre first three years 1,000 acre basis.

	Dollars.	Dollars per acre.
First year.		
Land per acre		20
Clearing, ploughing, hanowing 60 stumps per acre		
Tractor ploughing twice	6	
Piling and burning rubbish	2·25	
Draining and ditching	10·0	
Hanowing three times	4·50	
Invisible cost ..	3·25	
	35·00	
	5·00	30
Cost of tung trees at 73 trees per acre ..	14·00	
Planting and watering	7·30	21·90
Fertilisers, well balanced strong in nitrates, first year applied twice 2 lbs. per tree =292 lbs. at 2 cents	5·84	
Labour applying fertilisers 1 Dollar per acre per application ..	2·0	
One extra hoeing	1·0	8·84
Hanowing three times at 1·5 Dollars per time		4·50
Fencing (48-inch Hog proof wire). Cost of fencing 640 acres, 1 mile square 32 rolls of 660 feet at 18 Dollars	576·00	
Posts 2,112 at 1 cent	211·20	
Labour per panel at 5 cents	105·60	
Staples at 300 per 8 cents	24·00	
	916·80	
Cost per acre		1·43
Total for first year per acre ..		86·67
Equal to Rs. 239.		
Second year.		
Fertiliser well balanced—Increase 50 per cent. over first year 2 applications	8·76	
Labour 1 Dollar per application	2·00	
Hanowing twice at 1·5 Dollars	3·00	
Seed, baggar weed peas or beans ..	3·50	
One extra hoeing	1·00	18·26
Third year.		
About the same as second year		18·26
		123·19
For overhead expenses and contingencies 25 per cent. ..		30·79
Total for three years		153·98
Equal to Rs. 424.		

Taking the figure at 200 Dollars per acre the cost in rupees would be Rs. 550.

In the book "Tung Oil Production in United States of America, 1926," by M. A. Hall, it is stated that the following table is regarded in America as a reasonable estimate of yield for tung trees :—

is 20 lbs. of seed in $1\frac{1}{2}$ to $1\frac{3}{4}$ hours crushing, while their efficiency is even less than the bullock driven machine. Mills are equipped with 100 to 300 of these primitive machines. It is noticeable, however, that such machines are gradually being replaced by modern hydraulic presses or by oil expellers, and it is merely a question of time before they are extinct.

The power-driven ghannis are usually made by the mills using them. Such mills usually have their own foundry and wood-working plant ; it is usual for such mills to make and supply ghannis to outside people. The price of one pair of these machines is approximately Rs. 350.

The annual cost of upkeep is exceedingly heavy. There is little doubt that if all firms keep a definite and accurate record of cost of production and cost of upkeep and annual repairs they would find that at times the mill made no profit whatever. Usually after 3 weeks work some part has to be replaced. The annual cost of upkeep ranges between 50 and 80 per cent. per annum. The cost of crushing amounts to 14 or 15 annas per maund of seed when interest on capital, rent, rates, taxes and depreciation are calculated.

APPENDIX XXI.

The village teli—His plant and methods.

The bulk of the vegetable oil made in India is produced with a very primitive type of mill known as a kolhu or ghanni. Practically the whole of the mustard oil is thus crushed. In almost every village in India there is the "teli" or oil miller. His mill consists of a mortar cut out of a tree trunk, usually tamarind wood or babul. These woods are used since they are hard. The mortar is about 20 inches in diameter and 4 feet in length, of which 2 feet 6 inches are sunk in the ground. A hole is bored in the tree trunk 6 inches in diameter by 6 to 8 inches deep; in this hole rotates a piece of wood as a pestle, the movement being given by an undersized blind folded bullock walking around for 3 or 4 hours at a time in a circle varying from 8 to 12 feet in diameter. A charge of 6½ lbs. of seed is placed in the mortar and about 1/8 lb. of water added, which moisture activates the enzyme in the mustard seed, thus producing the mustard aroma or flavour. It occupies 3 to 3½ hours, depending upon the time of year, to crush 6½ lbs. of seed; the yield of oil is approximately 2½ lbs. of oil. As the process is proceeding it is usual to increase the pressure. This is done by either the teli, his wife or child sitting on a small wooden platform suspended on the pestle until the process is completed. The extraction of oil averages about 33 per cent., no matter whether the seed contains 38 or 50 per cent. of oil. The methods in use are antiquated and wasteful, especially as the bulk of the oil produced in India is made in this wasteful and laborious manner. The outfit of bullock and ghanni costs approximately Rs. 50 depending upon the quality of the bullock. The cost of annual repairs is about Rs. 20.

The income from this business is extremely small, and a cost sheet would undoubtedly show that much of the labour was not paid for. The total earnings are about 8 annas to Re. 1-2 per diem, out of which the bullock has to be fed and depreciated with the other plant, and usually high rates are paid as interest on loans or finance of seed purchased.

During the past year on account of the relatively high price of mustard seed as compared to oil and cake there has been an increased tendency to make adulterated oil. Linseed and groundnut oil having been unusually cheap, the oil from these seeds are mixed with mustard oil and sold as "No. 2 quality" oil, which has added considerably to the teli's profit. The mustard seeds crushed are any of the following:—

Brassica Compestris.	Eruca Sativa.
Brassica Juncea.	Brassica Napus.

The teli or oil miller is not particular which seed he uses; the selection depends entirely upon the ruling price for seed. The larger mills are equipped with power-driven machines of a very similar type to the bullock power machine. These power-driven machines are worked by steam or very often by electric power. They consume approximately 1 to 1½ H. P. each, but their capacity

on the material and trying to assess its value as a paper-making material, I think it is necessary and desirable to confirm the laboratory results by carrying out semi-commercial or commercial tests. It is not possible to perform the tests on a large scale here as we have not got a kollergang or rod mill for the intermediate mechanical treatment. There is a kollergang at Lucknow Paper Mills. I am sure the firm there would be interested in the experiments and would agree to have the tests carried out in their mills. Either we may approach the firm directly or the Principal, Technological Institute, Cawnpore, may fix up for carrying out the experiments there through the Director of Industries, United Provinces. Probably the Industries department, United Provinces, may also pay the cost of raw materials, chemicals, etc., required for the experiments. The large scale trials at Lucknow would also indicate what lines of papers can possibly be produced from flax waste. I shall have to go to Lucknow to carry out the tests. I would also like to go to Cawnpore to see how the waste is obtained and to collect statistics regarding the possible supplies of the material to paper mills in this country.

3. Experiments on woody cores from flax waste will shortly be taken up to find out if it is possible to utilize them for the production of wrapping papers and straw-boards.

APPENDIX XXII.

Linseed straw as a possible source of income to the agriculturalist.

It appears that at present the straw from the linseed crop is not in any way used in India, with possibly a few exceptions where it may be used as litter for animals.

In 1902 experiments were carried out in Bihar and Orissa on flax growing which did not give any satisfactory commercial result.

The present proposals do not embody any attempt at growing flax, but merely to utilize the waste straw of the linseed crop after the harvest and the linseed has been separated.

The present method of separating the linseed from the straw destroys the fibres, as the operation is done by setting bullocks to tread out the seed, which breaks the straw into small pieces.

The method of threshing must therefore be altered.

The area under linseed in India is as follows:—

	Acres.
(*a*) Pure linseed crop	3,000,000
(*b*) Linseed as mixed crop	1,000,000
Total	4,000,000

The Second Economic Botanist to Government, United Provinces, gives the following estimate of yield of straw per acre from the average linseed crop in that province :—

Yield of linseed straw per acre lowest 10 maunds.

Yield of linseed straw per acre average 30 maunds.

The lower figure of 10 maunds per acre gives a figure for total straw available in India of 40 million maunds.

Some preliminary experimental work has been done by the author of this note on 699 lbs. of linseed straw obtained from the Agriculture Experimental Farm at Cawnpore.

The straw was tied in convenient bundles and retted by total immersion in water in small brick lined tanks measuring $8' \times 5' \times 4'\text{-}6''$ deep.

The straw, being inclined to rise to the surface, was weighted down with wooden planks with bricks placed on them.

The retting was done in April, 1930, the temperature of the water being 33° C. After $4\frac{1}{2}$ days the straw was removed from the retting tanks, washed with clean water and spread out in lines in thin layers with a grass rope over the straw, pegged down at each end to prevent the high wind carrying the straw away. The drying process occupied 4 days.

The straw was then placed between two pieces of grooved teak-wood arranged so that the grooves intermeshed each other. The upper piece of wood was weighted with 20 lbs. of lead, and this was attached to a lever so that the weight and the wooden piece could be raised and lowered on the straw.

This hammering action breaks the wooden core of the straw into pieces one inch in length and leaves the fibres unbroken. The fibres were then roughly combed to remove adhering pieces of core. The

comb consisted of sharpened and tempered knitting needles placed in a block of wood.

This process combed out cores and some short fibres.

The long fibres were again combed to clear out short fibres or tow.

The yield obtained from this experiment was as under:—

Long fibres 14 to 18 inches in length ..	47·75 lbs.	=6¾ per cent.
Short fibres or tow	150·00 „	=21 „
Wood cores	391·00 „	=55¾ „
Loss in wastage due to wind blowing portions away.	110·25 „	=16·5 „
	699·00	

This straw was longer than can be expected from the average crops available in India at present. It is considered probable that the average long fibres will be 12 inches in length. The loss is perhaps much greater than it would be on treating large quantities.

Estimate of results from treating 40 million maunds of linseed straw :—

	Maunds.
Long fibres 12 inches in length	2,700,000
Short fibres or tow	8,400,000
Wood cores	22,300,000

The long fibres are suitable as raw materials for village weavers, rope makers or could be worked up into binder twine and exported.

The short fibres or tow and the wood cores were submitted to the Forest Research Institure, Dehra Dun, where the opinion has been expressed that the tow is suitable as raw material for the finest quality of paper, such as Ledger paper, and that the cores are suitable for straw-board manufacture.

The Forest Research Institute has been asked to obtain a valuation of the various products.

Samples of the short fibres were submitted to the Managing Agents of the Titaghur Paper Mills who placed a value of Re. 1 per maund on these fibres if delivered in a clean state free from woody cores.

Linseed straw.

The department of Industries, United Provinces, has been experimenting for four seasons on the production of fibres from linseed straw after the seed crop has been harvested. It is proposed to call the fibre "Linseed straw fibres" so as not to confuse it with flax which is obtained from the linseed when pulled green and the seed is immature. The experimental work was taken up with a view to increasing the income of the agriculturalist and not with a view to any attempt at producing fibres of the quality of flax as grown in Europe and used in the production of linen. The experimental work has been successful, and the production of the fibre can be undertaken in the villages. The plant required is of a very simple type and has been devised so that the entire plant can be made by the village people at exceedingly low cost

There are at present certain difficulties in developing the business, but they are of such a nature that they can be easily overcome.

1. The present method of setting bullocks to tread out the seed must be abandoned, and in place of this method the cut crop is combed by means of pulling the straw once or twice through a comb made of 5-inch iron nails set in a piece of timber. This comb costs a few annas and is again used in extracting the fibres. The seed is very easily removed.

The combed straw is then tied in convenient bundles 4 to 6 inches in diameter and placed in pits, preferably brick lined, or in a stream where the straw is placed between earthen bunds and weighted down with stones or bricks, or in the case of brick lined pits pieces of wood or bamboo are placed across from side to side in order to keep the straw below the water during the process of retting.

Retting takes approximately 5 days. Prior to retting pieces of hard root should be chopped off with a wooden chopper or a knife.

The retted straw is then removed from the pits, roughly washed with clean water, drained and the bundles opened up and spread out to dry. As there are high winds in March, April, May and June it is advisable to place a string or wire over a line of straw pegging it down every 20 feet to prevent the straw being disarranged and blown away. The drying of the straw takes about 3 days, after which it is passed on to the breaking machine. In France and Ireland where the flax industry is highly developed the retted straw is sent to scutching mills where it is freed from the woody cores and passed on to the spinning mills. Such scutching mills possess expensive and up-to-date plant and the flax is grown in districts close to both the scutching, spinning and weaving mills. In India the problem must be tackled differently on account of the wide areas over which linseed is distributed and the consequent cost of freight.

It was for this consideration that primitive plant has been devised so as to overcome the carrying of much bulky material and to give the agriculturalist employment and some gain in an effort to raise him from his present state of poverty. The breaking mills of France, Belgium and Ireland consist of grooved rollers which crack the wood core or shive into pieces about 1 inch long, the fibres being left unbroken. In the plant devised for use in the United Provinces the machine already in use in villages for bruising gram and other cereals is brought into use. The only alteration to the plant being that a block of wood with $\frac{3}{4}$ inch grooves on its upper surface is placed in the ground ; above this is intermeshed in the grooves a similar surfaced piece of wood which is weighted with a 20 lbs. piece of iron or lead.

This upper block is raised and lowered by means of a long lever worked by the operator's foot, whilst another person passes the dry straw between the two pieces of wood. This breaks the shives into $\frac{3}{4}$ to 1 inch pieces, and much of it separates out at once or by shaking the broken straw. There is, however, a considerable amount of woody matter which is combed out by means of the comb mentioned above, thus combing clears out all woody cores and also combs out the short fibres contained in the branches of the plant.

The department of Industries, United Provinces, is having experiments made with the long fibres being made into ropes. They would probably be good enough for making such things as rope and belting or for binder twine.

The short fibres can be used as a material for making the best quality paper.

The woody cores are suitable for the manufacture of straw-boards. Samples of the two latter have been submitted to Forest Economist, Dehra Dun, for paper manufacture and straw-board manufacture. A copy of his report is attached. Samples have also been submitted to paper mills, and further large scale experiments are to be carried out.

The area under linseed in India is approximately 4 million acres. The yield of linseed straw at the lowest is 10 maunds per acre. The average is probably 30 maunds per acre. Taking the lowest figure as a basis the total straw available is 40 million maunds.

In the experiments done last year the yields of fibre and cores were as under :—

Long fibres 14 to 18 inches long	6¾ per cent.
Short fibres and tow ..	21
Wood cores ..	55¾
Loss	16·5

The length of the fibres may be on the high side for average of Indian linseed, but the length could be improved by slightly closer planting and the use of the variety produced by the Agricultural department, United Provinces. It is not unlikely that the figures given above will be considerably improved upon when the results of this year's experiment are completed.

The yield of fibres would certainly be much greater if modern flax machinery was available.

Copy of letter no. 2/30—12/p.p., dated May 13, 1931, from the Forest Economist, New Forest, P.O. Dehra Dun, to the Director of Industries, United Provinces.

With reference to the attached note by Mr. M. P. Bhargava, the officer in charge of the paper pulp section at this institute, I would ask you whether you can arrange for Mr. Bhargava to carry out the large scale test on flax waste mentioned in this note at the Lucknow Paper Mills.

I think that it would be best for you to arrange for this rather than that we should do it, as the inquiry arose originally from a letter from the Principal, Harcourt Butler Technological Institute, Cawnpore, and is of interest to many, including the Lucknow Paper Mills, who, if the experiments are successful, would have a new source of cheap raw material thrown open to them. The question of the cost of the raw materials and chemicals used in the tests is also one which should be settled. This again is more the concern of your department rather than the Forest Research Institute.

In conclusion I may say that we consider the large scale experiments as proposed by Mr. Bhargava would be well worth while, as this flax waste shows every promise of providing a new cheap but good material for paper making.

Investigation on flax waste sent by the Principal, Harcourt Butler Technological Institute, Cawnpore.

Three samples of the waste, viz., (*a*) long fibres, (*b*) short fibres or tow, and (*c*) woody cores were sent here for investigation. The long and short fibres contained a large number of shives entangled in the mass and not easily or economically separable. Whilst the fibres were easily digestible and bleachable, the shives were found to be rather refractory to chemical treatment, with the result that pulp obtained by the normal process of digestion contained a fairly large proportion of partially cooked fibres and shives. A departure from the normal process was, therefore, made by subjecting the partially cooked mass to mechanical treatment prior to second stage digestion, or in the case of "overhead" method of digestion prior to bleaching. In this way the shives were sufficiently disintegrated to be attacked by chemicals and a satisfactory yield of clean bleached pulp was obtained. When digested with 16 per cent. caustic soda by the "fractional" method the material required 2·3 per cent. standard bleaching powder and yielded nearly 43 per cent. bleached pulp of fairly white shade. When digested by the "overhead" method the material required 10 per cent. caustic soda, 5·2 per cent. bleaching powder and yielded nearly 50 per cent. bleached pulp of slightly yellowish shade. This pulp can be used, I think, for the manufacture of ordinary grades of white papers. Average length of fibres is found to be 4·75 mm., maximum being 11 mm. and minimum 1·5 mm. I attach herewith a sample sheet of pulp for your inspection. Grit from concrete rollers of our kollergang is responsible for the few black specks which appear in the sheet.

2. Approximate average figures for the quantities of raw materials and chemicals required to produce a ton of bleached pulp from flax fibres, sabai grass and bamboos are as below:—

—	Raw materials.	Caustic soda.	Bleaching powder.
Flax waste (1) Fractional method ..	46·5 cwts.	7·4 cwts.	1 cwt.
(2) Overhead method ..	40·0 ,,	4·0 ,,	2 cwts.
Sabai grass (Fractional method) ..	52·5 ,,	6·8 ,,	1·25 ,,
Bamboos (Fractional method) ..	45·0 ,,	8·0 ,,	2·0 ,,

It will be seen from the above table that the chemical cost of pulping flax waste is less than that in the case of bamboo, and it compares very favourably with that of pulping sabai grass, particularly if the waste is digested by the "overhead" method. As the length of fibres from flax waste is nearly 5 mm., the pulp from it can be used for the manufacture of better classes of papers and for blending with short fibre pulps, e.g., from grasses, etc. Flax waste, therefore, appears to be an excellent paper-making material, and I dare say would be welcomed by paper mills in this country as a supplementary source of raw material. Before, however, expressing a definite opinion

machines. Pulleys, bearings and typical machine details. Rivetted joints, piping joints, shaft couplings. Foundations for buildings and machines, stanchions, beam connections, simple roof truss.

Design of small apparatus and machines. A project giving details of a workshop or small factory in a selected locality.

ENGINEERING WORKSHOP AND LABORATORY.

Use of hand and machine tools for wood. Various types of joints. Elementary pattern-making. Foundry principles, moulding, simple castings. Forge and smith's work. Drawing down, upsetting and welding. Tool dressing case, hardening. Fitting, chipping and filing, simple tool-making, fitting and lining shafting. Use of lathe, drilling machines. Dismantling and erection of machines.

Flow of liquids in pipes, running and tests on boilers. Steam engines. Internal Combustion Engines. I H. P. and B. H. P. tests. Dynamometers. Chimney draught. Simple tests on electrical machinery, switch gear, motors, wiring and connexions.

APPENDIX XXIII.

List of subjects included in the courses for all students at the Harcourt Butler Technological Institute, United Provinces, Cawnpore.

The following general principles were accepted as the basis for drawing up the curriculum:—

(*a*) That students admitted to the institute will have general education up to the standard of Intermediate in Science (or its equivalent) with Chemistry and Physics as subjects.

(*b*) That the course of training at the institute will be of three years' duration in the following departments, and such others as may be added later on:—

(i) General Applied Chemistry.
(ii) Oil Chemistry and Technology.
(iii) Leather Chemistry and Technology.
(iv) Sugar Chemistry and Technology.

2. The following subjects were considered to be of sufficient importance to be made obligatory for students of all departments:—

(*a*) Chemistry (Organic, Inorganic and Physical).
(*b*) Physics.
(*c*) Applied Chemistry (General course).
(*d*) Mechanical Engineering.
(*e*) Drawing.
(*f*) Workshop Practice.
(*g*) Fuels and Combustion.
(*h*) Bacteriology and Bio-Chemistry.
(*i*) Industrial administration, including Book-keeping.
(*j*) The use of Statistics.

German and French should be optional subjects.

The courses of instruction in the above subjects should be arranged in a progressive manner from the first to the third year.

A large number of common subjects should be taken in the first year so that the specialized courses and large scale work may receive more attention in the third year.

The scope of the syllabuses in the common subjects is briefly indicated below, it being left to the department and the Principal to work out details and fix the time-table.

3. *Chemistry.*—Instruction should be given in Organic, Inorganic and Physical Chemistry, taking as a starting point the standard up to which these subjects are taught for the Intermediate Examination in Science. The scope of the course should be such as to cover the entire ground required for the technological subjects.

Practical work in the laboratory should receive special attention, and should go hand in hand with the course of lectures.

4. *Physics.*—Instruction should start from the Intermediate standard, and should keep in view the requirements of the technological subjects.

A selection course covering subjects such as the following should be drawn up:—

Molecular physics, Kinetic theory of gases, Calorimetry pyrometry, Principles of thermo-dynamics, Optics, Electro-Chemistry, and electrical measurements.

Practical work should be emphasized.

5. There is a course of general applied chemistry in the curriculum of the institute at present.

The course is obligatory for all first year students.

It comprises 64 lectures and practical work in the laboratory, and in the semi-large scale chemical plant.

The sub-committee consider that this course should be considerably curtailed, and only such portions of it retained in the common course as are of equal interest to all the departments.

The remainder of the present course should be included in the special subjects for the general applied chemistry department.

6. *Mechanical engineering.*—The courses should be of a descriptive rather than of a theoretical and mathematical nature, the object being to teach students how to handle, run and maintain the more important machines, and certainly not to design and construct them. Instruction may be given on the properties of steam, steam boilers and their accessories, engines (steam, oil and gas), indicator diagrams, testing of efficiency, boilers, engines and other machines, adjusting them to obtain maximum efficiency. The properties of materials used in building and foundations and in plant, as also the sources from which they are obtained, should be included in the lectures.

Special stress should be laid on work in the engineering laboratory, which should be suitably equipped with machines and instruments for practical instruction.

7. *Drawing.*—The training in this subject should be such as will enable students to read and understand drawings, as also to express their ideas by means of simple sketches.

An extensive course such as is required for draftsmen is not to be aimed at.

8. *Workshop practice.*—This should cover training in the use of tools other than workshop machines and machine tools. Opportunity should also be afforded for gaining experience in moving heavy machinery and also in dismantling, re-erecting and overhauling common machines. The students should also spend some time in the repair shop and foundry.

9. *Fuels and combustion.*—Instruction should be given in the principles and practice of the economic use of different kinds of fuels, including properties of various types of furnaces, chimneys, economisers, feed heaters and similar fuel saving appliances.

Laboratory work should include analysis of fuels, determination of calorific value, analysis of fuel gases and calculation of efficiency and preparation of a thermal balance-sheet.

10. *Bacteriology and Bio-Chemistry.*—Elementary lectures and laboratory work should form part of the common course, and should include instruction in the use of the microscope, preparation of pure

cultures and study of enzyme action. More detailed and specialised courses should be included in the sugar and leather departments.

11. *Industrial administration.*—As it is the object of the institute to turn out men who will eventually occupy not only technical but also high administrative position in industry, there should be a course in industrial administration comprising the following branches :—

(i) Economic Geography, more particularly of India.
(ii) The principles of costing.
(iii) The Indian Companies Act.
(iv) The Indian Factory Act.
(v) The Indian Boiler Act.
(vi) The Workmen's Compensation Act.

12. The use of the statistical data of Indian trade and industries.

Courses of studies in Bio-Chemistry.

BACTERIOLOGY AND FERMENTATION CHEMISTRY.

Course 1.—Lectures, Thursday, 11-30 to 12-30.

Laboratory, Friday, 9-30 to 12-30.

This course is intended to form an introduction to the science of Bacteriology in relation to sugar, leather and oil industries.

1. Bacteriology development.
2. Classification of bacteria and allied micro-organisms.
3. General morphology and physiology of bacteria and allied micro-organisms.
4. Methods of pure culture.
5. Chromogenic, photogenic and theremogenic bacteria.
6. Heat resisting bacteria.
7. Fermentation.
8. Chief enzymes and their actions.
9. Lactic, butyric and acetic acid fermentation.
10. Bacteria in relation to brewing, tanning and other fermentation industries.
11. Bacterial examination of water and air.
12. Disinfectants.

LABORATORY.

Use of microscope.

Methods of mounting and staining bacteria and allied micro-organisms.

Preparation of nutrient media.
Methods of sterilization.
Life history of a few better known micro-organisms.
Isolation of more important enzymes.
Isolation of selected bacteria.
Methods of distinguishing various yeats and moulds.
Standardization of disinfectants.
Bacteriological examination of water.

ENGINEERING "A".

I year.

Heat Energy.—Sources, methods of measurement and transfer.

Properties of steam.—Dryness factor, total heat and superheat, saturated and super heated steam.

Generation of steam.—Types of boiler, construction, mounting and operating characteristics. Fuel, draught economisers and superheaters, valves, pumps and accessories.

Use of steam.—Reciprocating steam engines, general construction and operating characteristics. Indicated and brake H. P. Effect of expansion, clearance, compression, condensation. Crank effort diagrams. Valves and valve gear. Governors. Objects of compounding. Thermal and mechanical efficiency. Running costs. Turbines. Evaporators, condensers and cooling ponds.

II year.

Liquid and gaseous fuels.—Producers. Internal combustion engines. General construction and operating characteristics. Typical cycles. Oil supply, vapourisation, air supply, ignition, governing, cooling modern types of steam and I. C. engines, economic characteristics.

Elementary principles of Thermodynamics applied to Steam and engines and turbines. Internal combustion engines. Air compressors. Refrigerating machinery.

Applied Electro-Magnetism.—Magnetic properties of materials, magnetic circuit, magnetic instruments and testing magnetic circuit. Direct current electricity. Primary and secondary cells. Magnetic effect of electric current. Heating effect. Resistance, EMF capacity. Direct current generators shunt series and compound voltage regulation. Losses and efficieny.

III year.

Direct current motors.—Construction, operating characteristics, torque and power, speed variation, starting switches, measuring instruments.

Alternating current principles.—Effects of inductance and capacity. Average and virtual values. Sine curve. Impedance, reactance and inductance power in an A. C. circuit. Power factor. Generation and transmission of power. Single and polyphase systems of generation and transmission of power. Transformers, types and characteristics. A. C. motors. Synchronous induction and slip ring motors, operating characteristics, torque power and speed control devices.

Utilization of power.—Cables construction, permissible loading, fuses and cut-outs. Minor wiring and fittings, insulation tests. Watt meters and energy meters. Commercial measuring instruments. Lighting and illumination. Types of motor for specific duties.

MACHINE DRAWING.

Lettering, scales, principles of projection. Preparation of working drawings from rough dimensioned sketches and notes of actual

APPENDIX XXV.

Expenditure of the Oil department Harcourt Butler Technological Institute, Cawnpore.

'A' NON-RECURRING EXPENDITURE.

		Rs.
1.	Value of existing machinery	35,912
2.	Value of existing factory buildings, machinery foundations and general masonry work ..	6,100
3.	Estimated cost of new—	
	(i) Machinery	1,08,300
	(ii) Building extensions	39,420

'B' RECURRING EXPENDITURE.

	Current expenditure.	Ultimate expenditure.
	Rs.	Rs.
Head of Oil Department Rs. 1,250+250 ..	18,000	18,000
Lecturer in Oil Chemistry Department Rs. 350—50—600	5,850	7,260
Laboratory Assistant 1 on Rs. 60—4—100 ..	960	1,200
Running Oil Mill	14,400	14,400
One coolie on Rs. 15 and one on Rs. 15—1—20 ..	372	420
Purchase of hides and skins	1,200	1,200
	40,782	42,480

APPENDIX XXIV.

Syllabus of oil Technology.

THEORY.

1. General properties and composition of oils, fats, and waxes.
2. General idea of the mineral oil industry.
3. Detailed study of the following important Indian Oils. Linseed, Safflower, Poppy seed, Niger seed, Sesame, Groundnut, Mustard, Castor, Mahua, Cocoanut, Ghi, Fish, Tallow and Neem.
4. Detailed study of the following machinery and plant with working details :—
   (i) *Machines for handling of raw materials.*—Bucket elevators, Belt conveyors, Roller conveyors, Screw conveyors, Vibrating troughs, etc.
   (ii) *Preparatory machines.*—Seed cleaning machines, Decorticating machines, Disintegrating machines, Milling machinery and Rolls of various types and Edge runners.
   (iii) *Pressing machines.*—Ghannis (Ordinary and Power driven), hand screw presses, Anglo-American presses, Cage presses, Accumulators, Hydraulic pumps, Oil expellers and Solvent extraction plant.
   (iv) *Finishing machines.*—Filter presses, Centrifuges and pumps.
5. Plant for, and methods of refining, bleaching and deodorissing of oils and fats.
6. Detailed study of the manufacture of soaps, and the plant required for the production as below :—
   (*i*) Cold process, semi-boiled and full boiled soaps.
   (ii) Hard and soft soaps for various purposes.
   (iii) Milled soaps and milling machinery.
7. General idea about the manufacture of fatty acids and glycerine manufacture by the following processes:—
   (i) Autoclave saponification.
   (ii) Twitchell's process.
   (iii) Lipase fermentation process.
   (iv) Refining of fatty acids and glycerine.
   (v) Candle manufacture.
8. Detailed study of the various methods of the manufacture of double boiled and pale boiled oils with the preparations of various driers used in the Industry.
9. Manufacture of oil and spirit varnishes with the study of resins used.
10. Preparation and uses of the following pigments:—
   (i) Natural earths.
   (ii) Chemical pigments.
   (iii) Artificial lake pigments on various bases for use as distemper colour printing, ink colours and paint colours.
11. Study of the grinding and preparatory machines for paints and enamels.

12. Detailed study of the manufacture of soaps given below :—
(i) Cold process.
(ii) Semi-boiled, and
(iii) Full boiled.
13. Manufacture of sulphonated oils.
14. Manufacture of industrial hydrogen and hydrogenation of oils with study of catalysts and their recovery processes.
15. Book-keeping and factory accounts, forms, etc.

PRACTICAL.

I.—Analytical.

1. Estimation of oil in seeds and other materials.
2. Determination of physical and chemical contents of oils, fats and waxes. Identification of individual oils and mixtures not exceeding two oils.
3. Refining of technical and edible oils including bleaching and deodorisation.
4. Analysis of cakes for feeding and manurial purposes.
5. Analysis of lubricating oils and lubricants.
6. Analysis of glycerine.
7. Complete analysis of filled and pure soaps.
8. Analysis of paints, varnishes and pigments.
9. Analysis of sulphonated oils and batching oils.

II.—Preparations and workshop practice.

1. Working fitting and adjusting of different machines used in oil pressing industry with calculations and details of working.
2. Manufacture of cold, semi-boiled and full boiled soaps and costing.
3. Manufacture of milled soaps and non-milled toilet and other soaps and costing.
4. Manufacture of driers and boiled oils, with costing.
5. Preparation of earth colours, chemical pigments and lake pigments and their grinding for paints, enamels, distempers, etc.
6. Preparation of oil and spirit varnishes.
7. Preparation of sulphonated oils.
9. Laboratory experiments for hydrogenation of oils and spliting of oils.

ORGANIC CHEMISTRY.

I Year.

Homologous series. Hydrocarbons of the paraffin, ethylene and acetylene series. Halogen derivatives and their reactions. Monohydric and polyhydric alcohols : Ethers, esters, aldehydes, ketones. Sugars, cellulose and starch. Saturated and unsaturated acids, higher fatty acids, oils, fats and waxes.

Dibasic and hydroxy acids, ketonic acids and their synthetic reactions. Stereoisomerism. Anhydrides, amides, imides. Nitroparaffins, amines, cyanogen compounds and sulphur compounds.

Proteins, aminoacids and the purine group. Grignard's reaction. Organometallic compounds.

II Year.

Coaltar, Its distillation products. Structure of Benzene. Halogen compounds, Nitro compounds, and their reduction products; amino, Diazo and Azo compounds. Sulphonations, Mono and Polyhydric Phenols; alcohols, aldehydes, ketones, Quinones. Monobasic, dibasic and phenolie acids and their anhydrides, tannins, terpenes and camphors. Naphthalene and Anthracene, Heterocydic compounds; alkaloids.

Physics.

I Year.

Properties of matter : Gravity, equilibrium, inertia, force, work, power, pressure of gases and liquids, pumps, hydraulic press, liquids and gases in motion, viscosity, diffusion surface tension.

Heat.—High and low temperature measurements, absolute zero, heat unsulation, ventilation, transference of heat; mechanical and electrical equivalent of heat, properties of steam, total heat, superheat and dryness, vapour pressure and distillation.

Light.—Refraction of light, refractometer, microscope, colour polarisation of light.

Magnetism and Electricity.—Electro static units, energy of a condenser, electrometer, voltaic measurements, potential difference, current, resistance, back E. M. F., Secondary cells, Joule's law, magnetic properties of iron, electro-magnetism and electro-magnetic units.

Physical Chemistry.

I Year.

Kinetic theory, gas laws, effect of molecular attraction on an expanding gas. Joule Thomson effect, liquification of gases. Theory of solutions; diffusion in gases and liquids; Osmotic pressure and the gas laws; relation between vapour pressure of a solution and the molecular weight of a solute; freezing point, boiling points and molecular weight relationships. Gas solutions, partition law. The ionic hypothesis; conductivity of solution; migration of irons; various applications in analytical chemistry; indicators and their application to the measurement of Ph. Law of mass action. Ostwalds' dilution law; balanced actions; various applications.

II Year.

Velocity of chemical reactions, effect of temperature, pressure and catalysts. Order of chemical reactions and its measurements; Exthermic and endothermic reactions; some important technical homgeneous reactions; heterogeneous reactions; catalysis. Electro chemistry; electrolytic solution pressure; concentration cells; hydrogen electrodes; electrolytic measurement of Ph.; Laws of electrochemistry; polarisation; decomposition voltages. Crystals; fractional crystallisation and growth of crystals, isomorhpism. Colloids, preparation and properties, emulsions, adsorption and allied surface phenomena, surface tension, adsorption of gases and vapours.

III Year.

Application of physical chemistry to manufacturing operations.

Thermodynamic considerations in explosion motors.—Producer operation. Metallic oxidations and reductions.

Reaction velocity and catalysis exemplified by Chamber.—Acid process, fermentation, fat splitting, oil drying, glass devitrification and annealing. Gas absorption and solution of solids.

Displacement of equilibrium.—Ether, nitric acid, soap manufacture, caustification of carbonates.

Phase Law applications.—Lime burning, lead roasting, alloys segregation, steel, gypsum and plaster of Paris cements.

Adsorption, Colloids, etc.—Lubrication, dyeing, vulcanisation, soap, dairy emulsions, clays, Ore flotation.

Applied Mechanic and strength of materials.

I and II Years.

Triangle and polygon of forces. Force, work, energy, power.

K. E. of rotating masses. Simple harmonic motion, screws, friction and lubrication. Transmission and measurement of power, gearing belts, ropes, etc. Pulleys, clutches. Stress, strain, elastic limits, elastic constants. Compound stresses, resilience, repeated stresses. Factors of safety B. M. and S. F. curves for simple cases of bending. Moments of resistance, simple theory of bending. Deflection, strength of beams; wood, steel C. I. and R. C. Torsion of a shaft. Combined bending and torsion. Springs, struts, thin shells, stresses in simple structures ; foundations.

Elementary fluid statics and dynamics.

Indore State.

617. Saddick Yusuf, Indore.
The seeds crushed in the above mill include Linseed, Til and Mahua.

North-West Frontier Province.

618. R. B. Karam Chand, Peshawar.
619. Billas Mills, Peshawar.
The seeds crushed in the above mills include Castor and Til seed.

APPENDIX XXVI.

Non-recurring expenditure of the Harcourt Butler Technological Institute (excepting Oil department) showing proportion chargeable to the Oil department.

Particulars.	Total expenditure.		Proportion chargeable to Sugar department.	Expenditure chargeable to Sugar department.	
	Already incurred.	To be incurred.		Already incurred.	To be incurred in future.
	Rs.	Rs.	Per cent.	Rs.	Rs.
A.—Buildings, land and equipment	1,35,615	..	25	33,904	..
Laboratories 1—5 and bungalows 6—7	2,00,685	..	25	50,171	..
Electric installation to above ..	2,906	..	25	727	..
Temporary hostel, etc. ..	31,238	..	25	7,809	..
Main building	4,93,069	..	25	1,23,267	..
Furniture and fittings ..	1,64,629	..	25	41,157	..
Mechanical engineering workshop	..	51,030	25	..	12,757
General Chemistry workshop ..	..	10,256	25	..	2,564
General buildings	..	18,068	25	..	4,517
Site formation	..	12,000	25	..	3,000
Work establishment	..	1,500	25	..	375
Electric installation	..	40,000	25	..	10,000
Water supply and drainage ..	..	1,30,000	25	..	32,500
Removal of workshop ..	..	20,000	25	..	5,000
New shafting	..	4,000	25	..	1,000
Servants' quarters	..	10,000	25	..	2,500
B.—Machinery—					
Mechanical engineering workshop	11,259	25,000	25	2,815	6,250
General applied chemistry ..	..	46,726	25	..	11,181

APPENDIX XXVII.

Recurring expenditure of Harcourt Butler Technological Institute (excepting Oil department) showing proportion chargeable to Oil department.

Particulars.	Total expenditure.		Proportion chargeable to Sugar department.	Expenditure chargeable to Sugar department.	
	Current.	Ultimate.		Current.	Ultimate.
I.—Pay of officers.	Rs.	Rs.	Per cent.	Rs.	Rs.
1. Principal, Rs. 1,500—50—2,000	18,249	24,000	25	4,812	6,000
2. Four Assistant Research Chemists	21,140	24,000	25	5,285	6,000
3. Industrial Chemist ..	7,260	7,260	25	1,815	1,815
Workshop Superintendent ..	4,560	8,400	25	1,140	2,100
II.—Pay of establishment.					
Draftsman	1,200	1,800	25	300	450
Workshop and gas mistries ..	1,892	2,400	25	473	600
Special pay to workshop mistries	120	120	25	30	30
Carpenter	504	600	25	126	150
Two fitters	1,420	1,500	25	355	375
Clerks and laboratory assistants (except Laboratory Assistant, Oil department)	10,778	12,000	25	2,695	3,000
Servants	3,864	3,936	25	966	984
Allowances	6,000	6,150	25	1,500	1,537
Stipends	10,000	18,000	25	2,500	4,500
Commercial operations ..	2,000	2,000	25	500	500
Chemicals and appliances ..	10,000	10,000	25	2,500	2,500
Purchase of materials ..	2,000	2,000	25	500	500
Gas manufacture	3,300	2,000	25	500	500
Other supplies and services ..	1,000	1,000	25	250	250
Contingencies provided for any particular expenditure ..	12,725	12,725	25	3,181	3,181
Future establishment of mechanical engineering	..	27,720	25	..	6,930

Serial no. *United Provinces*—(concld.).

86. Agra Oil Mills, Agra.
87. Ram Kishen Das Ramdev, Ghazipur.
88. Madan Mohan Dhama Lal, Ferozabad.
89. Moradabad Oil Mills Company, Moradabad.
90. Bundelkhand Oil Mills, Lalitpur.
91. Daryabad Oil Mills, Daryabad.
92. Ramnagar Oil Mills, Ramnagar.
93. Banwari Lal Rambharose, Cawnpore.
94. Kishen Das Kochbar, Dehra Dun.
95. The Oil Mills, Hathras, Hathras Killa.
96. The Farrukhabad Oil Mills Company, Ltd., Farrukhabad.
97. The Moradabad Oil Mills Co., Moradabad.
98. Ram Lal Banki Lal, Agra.
99. Coronation Oil and Flour Mills, Katra, Allahabad.
100. Ghanshiam Das Baijnath, Maithan, Agra.
101. Balbir Oil Mills, Dehra Dun.
102. Beeson Ram Castor Oil Mill, Ballia (Handpress only).
103. Ganga Ram Castor Oil Mill, Ballia.
104. Satnarain Castor Oil Mill, Ballia.
105. The New Modusil Company, Agra.
106. Saraya Oil Mill, Gorakhpur.
107. Mannalal Moolchand Somani Oil Mill, Lucknow.

The oil seeds crushed by the above mills, include linseed, til, mahua, castor and mustard.

Bengal.

108. Bidhi Chand Behari Lal no. 1, Calcutta.
109. Ditto no. 2, Calcutta.
110. Chuni Lal Seal's Mill no. 1, Calcutta.
111. Ditto no. 2, Calcutta.
112. Uma Charan Sadkhan, Calcutta.
113. Chandi Charan Sadkhan, Calcutta.
114. Sidheswar Garai Oil Mill, Calcutta.
115. Pudda Hari Pal Mill, Calcutta.
116. Md. Musaji Salaji Oil Mill, Calcutta.
117. Costo Behari Chatterji Oil Mill, Calcutta.
118. Parbati Charan Kundu Oil Mill, Calcutta.
119. Gour Mohan Saduskhan Oil Mill, Calcutta.
120. Bepin Behari Dutt Oil Mill, Calcutta.
121. Bhagwan Charan Sad Khan Oil Mill, Calcutta.
122. Bhawanicharan Ghosh and Son Oil Mill, Calcutta.
123. B. C. Nawan Bros. Oil Mill no. 2, Calcutta.
124. Gobardhan Das Dali Chand Oil Mill, Calcutta.
125. Bijoli Oil Mill, Calcutta.
126. Bidhichand Ram Dayal Dey Oil Mill, Calcutta.
127. Morong Roy More Oil Mill, Calcutta.
128. Manick Lal Sadhu Khan Oil Mill, Calcutta.
129. N. B. Dewan Oil Mill, Calcutta.
130. Sanwal Ram Oil Mill, Calcutta.
131. Sarat Chandra Bose Oil Mill, Calcutta.

Serial no. *Bengal*—(contd.).

132. Tincori Sadhu Khan Oil Mill, Calcutta.
133. Khetra Mohan Sadhu Khan Oil Mill, Calcutta.
134. Howrah Oil Mills no. 1, Howrah.
135. Ditto no. 2, Howrah.
136. Gourepore Oil Mills, Naihati.
137. Kanai Lal Sadhu Khan Oil Mills, Calcutta.
138. Kedar Nath Datt Oil Mill, Calcutta.
139. Salkia Oil Mill, Calcutta.
140. N. C. Atta's Oil Mill, Howrah.
141. Krishi Kesh and Gourhauri Ghose, Howrah.
142. Acine Oil Mills, Howrah.
143. Uma Charan Sadhu Khan Oil Mills, Howrah.
144. Mahadeb Sadhu Khan Oil Mill, Howrah.
145. Lillooah Oil Mill, Lillooah.
146. Pal Chowdhury Mustard Oil Mill, 24-Parganas.
147. Balai Chand Sadhu Khan Oil Mill, 24-Parganas.
148. Nityanando Saha Oil Mill, 24-Parganas.
149. Bhagwan Chandra Sadhu Khan Oil Mill, 24-Parganas.
150. Nawab Oil Mill, 24-Parganas.
151. B. C. Nawn Bros. no. 1, Mill, 24-Parganas.
152. Ditto no. 2, Mill, 24-Parganas.
153. Gour Mohan Sadhu Khan Oil Mill, 24-Parganas.
154. Lalit Mohan Sil and Sons Akshya Mill, 24-Parganas.
155. Bamapado Ghosh Oil Mill, 24-Parganas.
156. Ram Dayal Dey and Sons' Oil Mill, 24-Parganas.
157. Ram Chandra Ramnivas Oil Mill, 24-Parganas.
158. Sreemontalal and Amrit Lal Sadhu Khan, 24-Parganas.
159. Satish Chandra and Gubodh Chandra Sadhu Khan, 24-Parganas.
160. Kali Kumar Sadhu Khan, 24-Parganas.
161. Bishwanath Paramanick Oil Mill, 24-Parganas.
162. Debendra Nath Sadhu Khan and Bros. 24-Parganas.
163. Baikuntha Nath Chakarverty, 24-Parganas.
164. Manick Lal Sadhu Khan, 24-Parganas.
165. Bhagwan Das Mandal Oil Mill, 24-Parganas.
166. Bhamapado Ghosh and Sons, 24-Parganas.
167. Bhamapado Ghosh and Upendra Nath Ghosh, 24-Parganas.
168. The Berhmanpur Oil Mills, Murshidabad.
169. Hari Bhusan Dey Oil Mill, Burdwan.
170. Ram Dayal Dey Oil Mills, Burdwan.
171. Chotilal Gawarovala Oil Mill, Raneeganj.
172. Dybraj Oil and Rice Mills, Dubrajpur.
173. Balmukanda Kissen Gopal Rice and Oil Mill, Bishanpur.
174. Madan Mohan Basak Chakdah Oil Mill, Faridpur.
175. The Mymensingh Oil Mill, Mymensingh.
176. The Barisal National Oil Mill, Nabchitti.
177. Assam Bengal Oil Mill, Parbatipur.
178. P. K. Sen's Oil Mill, Chittagong.
179. Swaika Oil Mill, Lillooah.
180. Rai Saheb Benode Behari Sudhu, Calcutta.

Serial no. *Bengal*—(concld.).

181. J. B. Dastoor, Calcutta.
182. Mohendra Nath Sirder, Calcutta.
183. K. N. Lawyer, Calcutta.
184. Moosaji Salehji, Calcutta.
185. Jakuram Shri Kasuram, Calcutta.
186. Rai Saheb B. B. Sadhu, Calcutta.
187. Murarka Paint and Varnish Works, Calcutta.
188. Chait Ram Ram Bilas, Calcutta.
189. Indo-German Trading Company, Dacca.
190. Birdhi Chand Ram Kumar, Calcutta.
191. Sawai Ram Hardutt Roy, Calcutta.
192. Rai Charan Sadhu Khan, Calcutta.
193. Cromor and Company, Calcutta.
194. Durga Prasad Hari Shanker, Calcutta.
195. Jaggan Nath Brijraj, Calcutta.
196. Raja S. N. Law, Manick Tola, Calcutta.
197. Sone Valley Development Company, Calcutta.
198. Suraj Mal Kedar Nath, Calcutta.
199. G. H. Karmarkar, Calcutta.
200. Vishnu Rice and Oil Mills, Pirpainti.
201. Ram Das Ram Charan, Jamshedpur.
202. Juthiram Jankidas, P. O. Jugsalai, Tatanagar.
203. Mandakini Rice and Oil Mills, Khagra.
204. Bakhore Gange Oil Mill and Trading Company, Barisal.
205. Mohim Chander Ram Das, Calcutta.
206. Naup Chand Mangni Ram, Sitarampur.
207. Nepaul Chander Nag Oil Mill, Calcutta.
208. Paul Chaudhry's Mustard Oil Mill, Calcutta.
209. Radhanath Sadhu Khan Oil Mill, Salkea.
210. Rukni Kanto Das Oil Mills, Calcutta.
211. Isher Chander Ghosh Oil Mill, Calcutta.
212. Marwari Flour and Oil Mill, Burdwan.
213. Barisal National Oil Mill, Bakerganj.
214. Berhampore Oil Mills, Ltd., Berhampore.
215. Eastern Bengal Oil Mills, Jhalakate.
216. Dubrajpur Oil Mills, Birbhum.
217. Chandpur Oil Mills Company, Puranbazar.
218. Caledonian Oil Mills, Belliaghatta.
219. Barik Iron Foundry and Oil Mill, Calcutta.
220. Halsibagan Oil Mills, Calcutta.
221. Mujnai Rice and Oil Mills, Jalpaigori.
The oil seeds crushed by the above mills include linseed til, groundnuts, castor, mustard, cotton, copra and chaulmoogra.
222. Department of Industries, Madras.
223. P. Veerareddy & Co., Madras.
224. P. S. Velayudha Chetty and Son, Madras.
225. C. K. Samarapuri Chetty, Madras.
226. Sahib Ram Ramrathan & Co., Madras.
227. Sabapathy Pillai Oil Mill, Madras.
228. Gantakal Oil Mill, Timmencherla.

Serial no. *Madras.*

229. Ramchandra Rice and Oil Mill, Hindupur.
230. Reddijar Rice and Oil Mills, Narsinganpet.
231. M. Dubbish and Sons, Jamnalouadugu.
232. Vizianagram Press and Mills, Vizianagram.
233. Vupputuri Narasinha Rice and Oil Mill, Tenali.
234. Pandala Pullaya Rice and Oil Mills, Guntur.
235. Sri Kanya Raparameswar Rice and Oil Mills, Tenali.
236. Sri Lakshmi Mills, Kasargod.
237. Royal Rice, Oil and Saw Mills, Godi.
238. Ramdas Ramcharan Das Oil and Rice Mills, Calicut.
239. Mohomed Hussain & Co., Calicut.
240. Callianji Ginning and Pressing Company, Pollachi.
241. A. C. M. Abdul Razack Sahib's Rice and Oil Mills, Pollachi.
242. Muthu Bapanneas Oil Mill, Coconada.
243. Telugantla Rama Murthy's Oil Factory, Coconada.
244. Y. Uppanne Bros., Oil Mill, Coconada.
245. Ratham Subba Rao's Oil Mill, Coconada.
246. Heeranada Ram Sock's Oil Mill, Coconada.
247. Sri Krishna Rice and Oil Mills, Coconada.
248. Veerbhadrappa Veerbasappa Balloli, Kopbal.
249. Dr. P. Jagannatha Raja, Vizanagram.
250. K. Pooranandam and Sons. Begaada.
251. T. Pillai, Caddalore.
252. P. S. Govindaswamy Naidu, Coimbatore.
253. Pendali Pullayya ; Guntur.
254. Sri Krishna Rice Mills, Masulipatam.
255. Chandra Sakhara Chetty, Hindupur.
256. The Co-operation Society, Kalla Kurichi.
257. Ellayya Chetty, Nandyal.
258. Sanji Vappa and Sons, Adoni.
259. Tulsidas Morarjee, Coimbatore.
260. Kaka Manu Hanumayya, Narasaraspet.
261. Dalhupathi Jugannudham, Purangipuram.
262. Madi Setti Kotayya, Ongole.
263. Maruti Rice Mills, Ellore.
264. Pandyala Subbarao, Guntur.
265. Kolla Kotayya, Tenali.
266. Kolla Subbarao, Tenali.
267. V. V. and Sons, Kuppam.
268. K. Ramaswami & Co., Coconada.
269. Ellechetty Kondyachetty, Giddalore.
270. Vishnu Flour and Oil Mills, Bezwada.
271. R. Anantasu Bramanyan, Madras.
272. M. Abdul Halim Saheb and Mohd. Hussain, Calicut.
273. Sanyasiah Chetty, Vizagapatam.
274. Mahalaxmi Oil and Ginning Mills, Deoungaput.
275. S. A. V. Sabramania Chetty, Tirupatur.
276. Laxmi Narain Ginning and Pressing Mill, Kurnool.
277. Kerala Oil Mills, Calicut.

Serial no. *Madras*—(contd.).

278. Batchoo Vankata Rutnam, Coconada.
279. Laxmi Oil Mills Company, Ltd., Coimbatore.
280. Sri Krishna Rice Mills, Masuliaptam.
281. The Calicut Oil Mills, Calicut.
282. Chegu Subbarayadu and Sons, Guntur.
283. Dutt's Oil Mills, Calicut.
284. Kshmi Oil Mills, Ellore.
285. Matyalpalli Oil Manufacturing Company, Ltd., Kolar.
286. The Modern Oil Mill, Cuddalore.
287. The Peddapar Castor Oil Factory, Samalkot.
288. P. Srirumgum Chetty and Sons' Oil Mill, George Town.
289. Suryarowpeta Oil Factory, Coconada.

The oil seeds crushed by the above mills include copra, groundnuts, castor, linseed and mahua.

Bombay.

290. New Mahalaxmi Oil Mills, Bombay.
291. Haji Vali Mahommed Oil Mills, Bombay.
292. The New Oil Mill Company, Bombay.
293. Kalyanji Moorarji Oil Mill, Bombay.
294. Manikbhoy Oil Mill, Belgaum.
295. Hanuman Sugar and Oil Mills, Poona.
296. Rambhagat Pachandas, Poona.
297. Bijapur Mahalaxmi Oil Mills, Bijapur.
298. Vankatesh Oil Mills, Sangli.
299. Faeerappa Abbigeri Som Apps, Gadag.
300. Lekhaji Raj Roller and Flour Mills, Rajkote.
301. Kharandura Oil Mills, Bombay.
302. Haji Noor Mahomed Moosa, Bombay.
303. Basavraj Oil Mill, Gaday.
304. Abdul Haji Siddick, Bombay.
305. Mohd. Hussain Oil Mill, Jalgaon.
306. Abdul Shukkar Arabi, Bhavnagar.
307. Shree Krishan Oil Mills, Anand.
308. New Laxmi Oil Mills, Bombay.
309. Vali Mahomed Bhai Oil Mills, Bombay.
310. Dadwoodally Hirji & Co., Bhavnagar.
311. Khalida Harigwam, Bhavnagar.
312. Rajan Bhai Meherall and Son, Bombay.
313. Janno Hassan Oil Mills, Bombay.
314. Haji Tar Mohamed, Bombay.
315. Osmania Oil Mill, Bombay.
316. Ali Mohamed Abdul Rahim, Bombay.
317. Haji Ali Haji Abdul Shaukoor, Bombay.
318. Shree Natwar Singh, Porbandar.
319. Seth Ram Narain Jey Narain, Sangli.
320. Seth Pejeram Dedraj, Dhulia.
321. Shaparji Dhamjishaw Vakaria, Brooch.
322. Vishnu Bhaskar Ghokle, Bombay.

Serial no. *Bombay*—(contd.).

323. Joti Prasad Daulatram, Dhond.
324. Ismail Tarmohammad Islamic Oil Mills, Bombay.
325. The Poona Oil Mills, Poona.
326. The Sangli Oil Mills, Sangli.
327. Shirgaskar Brothers' Oil Mill, Kholapur.
328. Kotrappa Rachappa, Gudag.
329. Khanchand Jeramdas & Co., Karachi.
330. Lundaram Petlumal, Karachi.
331. Gulomal Moti Mal, Karachi.
332. Narain Das Tilokchand, Karachi.
333. Sibal Oil Mills, Karachi.
334. Dadhia Oil Mills, Ahmedabad.
335. Amalner Oil Mills, Amalner.
336. Haji Ismail Haji Mussa, Mazagaon.
337. Mohd. Ali H. Mahammed, Bombay.
338. Thakkar Kalianji Malji, Bombay.
339. Vishnoo Oil Mill, Bombay.
340. Haji Mohd. Ghulam Hussain Khan, Karachi.
341. Hussaini Oil Mills, Karachi.
342. Jan Mahomed Oil Mills, Byculla.
343. Bijapur Mahalaxmi Company, Bijapur.
344. Jan Mohamed Vali Mohamed Oil Mills, Bombay.
345. Seth Haji Adam Abdul Allana, Veravel.
346. Tribhovandas Harakishen Das, Kharsalia.
347. Dhampat Mal Diwanchand, Bombay.
348. Raja Gokuldas D. B. Jiwandas Oil Mills, Malakpur.
349. Sundar Singh Mohan Singh, Bahanddin.
350. The Graduate Coal Concern, Jalgaon.
351. The Samairam Joharmal, Bombay.
352. Kali Das Harjirao, Bombay.
353. Ali Mohamad Abdul Rahim, Bombay.
354. Kantilal Manni Lal, Bombay.
355. Haji Usman Haji Ali Mohammed, Bombay.
356. Basappa Bellary and Sons, Cadag.
357. Ashbhai Ashbhai, Anand.
358. Bapulal Shiv Lal Thakker, Baroda.
359. The Bansi Roller Flour Mill, Ahmedabad.
360. Amolak Kalyanji, Bombay.
361. Manick Oil Mills, Sholapur.
362. Haji Ismail Noor Mahomed, Bombay.
363. Moosa Abu Baker & Co., Bombay.
364. Ramchand Sahni and Sons, Karachi.
365. Banchand Gopalji, Bombay.
366. Jamna Das Ranchhordas, Jalgaon.
367. Kotak & Co., Bombay.
368. Malayya Venkayya Tamewar, Barsi.
369. N. E. Contractor, Badeli.
370. Mistri Jiven Vasta, Vadal.
371. Haji Moosa Suleman, Jamnagar.

Serial no. *Bombay*—(concld.).

372. Noor Mahomed & Co., Bhavnagar.
373. Shanker M. Patel, Nadiad.
374. Mehrally Moonji Mooki, Bhavnagar.
375. Laxmi Vigay Oil Mills, Porbunder.
376. Sri Natversingh Oil Mills, Porbunder.
377. Bejram Dedaraj Oil Mill, Dhulia.
378. Khushaldas Topendas, Karachi.
379. Bombay Flour and Oil Mills, Bombay.
380. The Sorat Oil Mills, Byculla.
381. The Connaught Oil Mills, Parel.
382. The Manchershaw Oil Mills, Bombay.
383. The Bhimani Oil Mills, Bombay.
384. The Merchant Oil Mills, Byculla.
385. Swadeshi Oil Mills, Bombay.
386. The Gujrat Oil and Manufacturing Co., Ahmedabad.
387. The Hindustan Oil Mills, Ahmedabad.
388. Rajnagar Oil Mills, Ahmedabad.
389. Sabarmati Oil Mills, Sabarmati.
390. Hargovind Das Lakmi Chand, Ahmedabad.
391. Hanumand Sugar and Oil Mills, Poona.
392. Godrej Oil Soap Works, Byculla.
393. Saraswati Oil and Manufacturing Co., Ahmedabad.
394. Carrimbhoy Mills Co., Ltd., Bombay.
395. Hira Chand Gangaram Oil Mills, Sholapur.
396. Kadi Oil Mills Co., Bombay.
397. Mahamed Ally & Co., Oil Mills, Sidhpur.
398. Sholapur Oil and Flour Mills, Sholapur.

The oil seeds crushed by the above mills include Copra, Groundnuts, Castor, Mahua, Linseed, Safflower, Cotton and Mustard.

Baroda State.

399. The Laxmi Oil Mills Co., Baroda.
400. The Kadi Oil and Ginning Factory, Kadi.
401. The Oil and Ginning Factory, Bhaldi.
402. The Patel Oil and Ginning Factory, Mehesana.
403. The Asian Oil Mill Co., Ltd., Kheralu.
404. The Gopal Oil and Ginning Factory, Dehgam.
405. The Indian Cotton Oil Company, Navasari.
406. Dyashai Vasmy Mardia, Navasari.
407. J. J. Vasamia, Bilimoria.

The seeds crushed by the above mills include Copra, Cotton, Groundnuts, Mustard, Linseed and Mahua.

Central Provinces.

408. Vittobha Atmaram, Kotpalliwar, Chanda.
409. Haji Umar Haji Mohammed Husain, Chanda.
410. Doulat Ram Narasing Das, Rajarundagaon.
411. Sree Ganesh Oil and Rice Mills, Gondia.

Serial no. *Central Provinces*—(contd.).

412. Shree Bajran Oil Mills, Kamptee.
413. Abdul Satar Haji Dada Oil Mills, Gondia.
414. Haji Ahmad Haji Saleh Mohammed, Bhusawal.
415. New Moffusal Co., Ltd., Pandharna.
416. New Moffusal Co., Ltd., Sheogaon.
417. The Cotton Ginning and Pressing Co., Neemuch.
418. New Moffusal Co., Napgur.
419. Bhusawala Oil Mill, Bhusawala.
420. Gondia Oil Mill, Gondia.
421. Seth Haji Latif Haji Dawood, Raipur.
422. Seth Ganga Shai Nathmal, Dongargha.
423. Seth Haji Noormahamed Moosa, Bhatapura.
424. Abdul Shakoor Sather Gaffur Bros., Naghbhir.
425. M. B. Oil Mills, Jubbulpore.
426. Akbar Manufacturing Co., Burhampur.
427. Prince of Wales Press Co., Ltd., Pulgaon.
428. Saraswati Oil Mills, Raipur.
429. Abheran Chuni Lal, Piparia.
430. Mathura Das Manna Lal, Malapur.
431. Malegaon Oil Mills, Malegaon.
432. Khandwa Oil Mills, Khandwa.
433. Abdul Rajbhai, Bhatapura.
434. Ramji Kahao Oil Mill, Amratoi.
435. Baldeolal Jagdeo Lal, Bilsapur.
436. Laxmi Oil Mills, Akola.
437. Abdul Ghani Wali Mohammed, Warora.
438. Berar Oil Works, Akola.
439. Kanao Dhamangaon Mill Co., Dhamangaon.
440. New Moffusil Co., Amraoti.
441. Seth Laxmi Narayan Oil Mill, Timerni.
442. Nath Onkardas Oil Mill, Timerni.
443. Munilal Baproolal Oil Mill, Jubbulpore.
444. Bhatapura Oil Mill, Raipur.
445. New Moffussil Co., Ltd., Pulgaon.
446. Dhan Flour and Oil Mills, Jubbulpore.
447. Sri Hukamchand and Dalmia Cotton and Oil Mills, Akola.
448. Vir Pratap Oil Mills, Lalitpur.

The seeds crushed by the above mills include Linseed, Til Mahua and Groundnuts.

Punjab.

449. Dewanchand Ram Singh, Tandlianwalla.
450. Krishen Prasad and Co., Nankhana.
451. Krishen Prasad and Co., Sahib.
452. Lala Radha Krishen, Lahore.
453. Guru Ramdas Oil Mills, Amritsar.
454. Diwanchand Jewan Lal, Gidderbah.
455. Dhanpat Mal Diwan Chand, Jaranwala.
456. Prabh Dayal Sheo Dayal, Hafizabad.
457. Sheikh Mian Muhammad Allahbax, Lyallpur.

Serial no. *Central Provinces*—(concld.).

458. Sheikh Mohammed Ismain Moula Bakhsh, Lyallpur.
459. Sheo Lal Mansaram, Rohtak.
460. Dhanman Chand Kishori Chand, Gujranwala.
461. Ilahi Bux Mahamad Rafiq, Kasur.
462. Bali Shah, Kasur.
463. Tavakar Mal Tara Chand, Sargodha.
464. Lakoomul Lalsing, Sargodha.
465. Chanchal Singh Jeswant Singh, Malakwal.
466. Nathuram Chiman Lal, Muktsar.
467. Mohamad Shafi Mahomad Sharif, Kasur.
468. Tula Ram, Jug Ram, Abohar.
469. Amanulla Fazaddin, Budhlada.
470. Mehar Singh Jiwan Singh, Chuharkana.
471. Malik Daryailal, Multan.
472. Fattichand Ramduttamal, Okhara.
473. Haitram Rama Krishna, Pattoki.
474. L. Ghaki Mal Hukam Chand, Ludhiana.
475. Ram Chand Sabni and Sons, Amritsar.
476. Jarwal Das Diwan Chand, Lyallpur.
477. Thakardas Shantram, Amritsar.
478. Sharma Brothers, Ludhiana.
479. Sardar Saijan Singh, Sialkote.
480. Krishna Oil and Flour Mills, Rawalpindi.
481. Kuldip Oil Mills, Lahore.
482. Krishna Ice Flour and Oil Mills, Montgomery.
483. Chawla Ice Rice and Oil Mills, Gujranwala.
484. The Ohri General Mills, Abohar.
485. The Suraj Oil Mills, Delhi.
486. Sheo Prasad Shri Krishen Das, Ludhiana.
487. Mohan Lal Luxmi Narayan, Nanakana Saheb.
488. Imperial Oil Soap and General Mills Co., Ltd., Delhi.
489. Katumal and Sons, Oil Mills, Amritsar.
490. Malik Thakur Das Mathura Das, Cotton Ginning and Oil Mills, Lyallpur.
491. Sir Ganga Ram Oil Mills, Montgomery.
492. General Mills, Amritsar.
493. Mohd. Ismail Maula Baksh, Lyallpur.
494. Capital Oil Mills, Delhi.
495. Rawalpindi Oil and Flour Mills, Rawalpindi.

The seeds crushed by the above mills include Mahua, Mustard, Rape, Linseed and Cotton.

Mysore.

496. Industries department, Mysore.
497. R. D. Muniappa and Byrappa, Bangalore.
498. M. N. Chigateri, Bangalore.
499. B. N. Gopalswamy, Mysore.
500. Shivaji Soap Nut Works, Bangalore.
501. Rama Krishna Oil Mills, Bangalore.
502. Narasingha Rao Scindia, Bangalore.

Serial no. *Mysore*—(concld.).

503. Shree Kanteshwara Rice Mill, Mysore.
504. Karnool Naraniah, Chichballapur.
505. Ajjampur Shetra Shivananjappa Davangire.
506. Balappa Bondlay, Davangire.
507. Brahamappa Thawanappa Ravara, Mysore.
508. Brahamappa Thawanappa Navaru, Davangire.
509. Kengeri Naganna, Bangalore.
510. Narasingh Rao Sindhia, Bangalore.
511. Reddi Byrappa, Bangalore.
512. C. Narasinahiya, Mysore.
513. Thibbana's Oil Mill, Mysore.
514. G. Mallappa, Bangalore.
515. Bondaday Balappa, Davangire.
516. Mysore Steam Oil and Rice Mills, Mysore.

The seeds crushed by the above mills include Linseed, Til, Dhupa, Castor, Copra, and Pongam (Honge).

Travancore.

517. The Assam Tile Factory and Oil Mill, Quilon.
518. A. S. Rishod Oil Mill, Vedrithalay.
519. The Kaleshwara Oil Mills, Kuthiathodu.
520. P. G. Oil Mills, Kuthiathodu.
521. Mathew Varkey Oil Mills, Shertallay.
522. Baban Lakshman Oil Mills, Shertallay.
523. P. John and Sons, No. 1, Oil Mill, Alleppey.
524. P. John and Sons, No. 2, Oil Mill, Alleppey.
525. N. C. Chacko Vazhathoppil Oil Mill, Alleppey.
526. S. A. S. Subbiah Oil Mills, Alleppey.
527. P. Joseph Bros., Oil Mills, Alleppey.
528. P. K. Mahaomed and Sons, Oil Mills, Alleppey.
529. R. N. Krishna-Shanoi Oil Mills, Alleppey.
530. V. S. Narambu and Co., Oil Mills, Quilon.
531. Messrs. Valiabhoy and Sons, Oil Mills, Quilon.

The seeds crushed by the above mills include Copra, Castor, Marothi and Pungam.

Rajputana.

532. Kotah State Oil Mill, Kotah.
533. Haris Chandra, Kotah.
534. Kuddin & Co., Jamnagar.
535. Ajmere Oil Ice and Flour Mill, Ajmer.

The seeds crushed by the above mill include Mahua, Mustard, Linseed, Til and Castor.

Kashmir State.

536. Krishna Mills, Srinagar.
537. K. W. B. Oil Mills, Srinagar.
538. Kashmir Commercial Co., Srinagar.

The seeds crushed by the above mills include Linseed and Mustard.

Serial no. *Gwalior.*

539. Gaekwar Oil and Chemical Works, Morar.
540. The Gwalior Oil and Soap Co., Ltd., Gwalior.
The seeds crushed by the above mills include Mahua, Linseed, Til, Mustard.

Hyderabad State (Deccan and Sindh).

541. Sala Kram Oil Mills, Secunderabad.
542. Peddy Rajaiah and Co., Jangaon.
543. B. N. Bhumaraddi, Gulberga.
544. The Ice and Oil Mills Co., Ltd., Shikarpur.
545. Hyderabad General Agency, Secunderabad.
546. Nawab Abdul Baseth, Khan Bahadur, Hyderabad.
547. Raighir Oil Mills, Raighir.
The seeds crushed by the above mills include, Linseed, Castor, Groundnuts, Mahua.

Cochin State.

548. Abdul Sattar Hajee Moosa, Rice and Oil Mills, Palliviruthi.
549. Dharsy Khetsey Oil Mills No. 1, Palliviruthi.
550. Dharsy Khetsey Oil Mills No. 2, Palliviruthi.
551. Abdul Hussain Abdul Kadir and Co., Oil Mill, Palliviruthi.
552. Walliabhai Kadirbhoy and Co., Oill Mill, Palliviruthi.
553. Hassam and Kassam Ayoob Oil Mill, Palliviruthi.
554. Adams Oil Mills, Palliviruthi.
555. Kannu Pillay's Oil Mill, Rameswaram.
556. R. S. Vasudeva Shenoi and Bros., Oil Mill, Vypeen.
557. The Perumanoor Oil Mills, Erakulam.
558. S. S. Koder's Oil Mill, Erakulam.
559. The Tata Oil Mills Co., Ltd., Erakulam.
560. The Kokkalai Rice and Oil Mills, Trichur.
561. The Poothole Rice and Oil Mills, Trichur.
562. Vasudiva Shenoi and Bros., Narakkal.
563. R. R. Menon and Co., Ernakulam.
564. Premji Ketseye Oil and Rice Factory, Cochin.
565. Vasudeva Shenoi and Bros., Vypeen.
566. Sri Krishna Oil Mills, Co., Mangalore.
The seeds crushed by the above mills include Copra and Groundnuts.

Burma.

567. H. F. Leslie and Co., Rangoon.
568. U. Ba Oh's Oil Mill, Rangoon.
569. Anglo-Burma Rice Trading Co., Rangoon.
570. Tye Tong & Co., Oil Mill, Rangoon.
571. Jamal Bros. and Co., Oil Mill, Rangoon.
572. Ellermans Arraccan Rice and Trading Co., Rangoon.
573. Jamals Cotton Produce Co., Ltd., Myingyan.
574. Lyan Lee Oil Mill, Rangoon.
575. Moola Oil Co., Rangoon.

Serial no. *Burma*—(concld.).

576. Hock Tong Moh's Oil Mill, Rangoon.
577. Sin Gin Him & Co., Oil Mill, Kemmendine.
578. Gin Hin's Oil Mill, Rangoon.
579. E. Thoung's Oil Mill, Rangoon.
580. E. M. Attia and Son Oil Mill, Kamayut.
581. U. Tun Hla, Pyilonsanda Oil Mill, Prome.
582. Mg. Khant's Danyatheiddi Oil Mill, Prome.
583. Ko. Aung Myat Kyaw Oil Mill, Henzada.
584. Mg. Theins Yatanabon Oil Mill, Mandalay.
585. U. Aung Cyaw's Myamabala Oil Mill, Mandalay.
586. U. Hlaing and Sons Ginning and Oil Mill, Meiktila.
587. Mg. The Daw's Thamakamanta Cotton and Oil Mill, Mahlaing.
588. S. M. Ali Akbar's Hamean Oil Mill, Nyaung—U.
589. U. Po Chan's Bawgawuna Oil Mill, Singa.
590. H. H. Khan Mahomeds Oil Factory, Pakokka.
591. Japan Cotton Trading Co., Oil Mill, Allanmyo.
592. Md. Jiwa Motala and Ismail H. Mamooji, Allanmyo.
593. Tea Aik's Oil and Flour Mill, Rangoon.
594. N. C. Das Oil Mill, Rangoon.
595. Burma Cotton Co., Myingyan.

The seeds crushed by the above mills include Groundnuts, Cotton, Tea seeds and Til.

Assam.

596. Dasuram Mirzamul, Gauhati.
597. Radhakrishen Oil Mills, Gauhati.
598. Lohiri Oil Mills, Gauhati.
599. Assam Bengal Foundry, Dibrugarh.
600. Brij Mohan Durga Dutt, Tinsukia.
601. Dibrugarh Oil Mills, Dibrugarh.
602. Narsingh Das Surajmal, Tinsukia.
603. Kanailal Makhanlal Oil Mill, Dibrugarh.
604. Ram Chandra Durga Dutt Oil Mill, Dibrugarh.
605. Narang Rai Udai Ram Oil Mill, Rehabari.
606. Ganapatrai Gorakram Oil Mill, Gauhati.
607. Suram Valley Saw and Oil Mills, Bhanga.
608. Halkatta Saw and Oil Mills, Dibrugarh.
609. Sree Ganesh Rice and Oil Mills, Nowgong.
610. Lakimpur Oil Mills, Dibrugarh.
611. Surona Valley Saw and Oil Mills, Sylhet.
612. Sylhet Oil Mills, Sylhet.
613. Tinsukia Rice and Oil Mills, Tinsukia.
614. Jamunadas Ram Kumar and Co., Tinsukia.
615. Eastern Assam Rice and Oil Mills, Tinsukia.
616. Chaparmukh Rice and Oil Mills, Chaparmukh.

The oil seeds crushed in the above mills include Linseed Rape, Til, Castor and Cotton seed.

Gwalior State.

86. Government Goal Soap Factory, Lashkar.
87. Gaikwar Oil and Chemical Co., Morar.
88. Gwalior Oil and Soap Factory, Gwalior.

Cochin State.

89. Floral Soap Works, Trichur.
90. Lochan Soap Works, Pudukkad.
91. Tata Oil Mills and Soap Works, Ernakulam.

Bhopal State.

92. Government Soap Factory, Bhopal.

North-West Frontier Province.

93. Isher Das Monalian Bahorian, Peshawar.
94. D. I. Khan's Nation Soap Works, Peshawar.

APPENDIX XXIX.

List of Soap Works in India.

Bihar and Orissa.

1. National Soap Works, Kashipore.
2. Tirhut Soap Factory, Muzaffarpur.
3. The Searmari Soap Factory, Bhagalpur.

United Provinces.

4. Shrigopal Oil and Soap Works, Cawnpore.
5. H. B. Technological Institute, Cawnpore.
6. Benares Hindu University, Benares.
7. Sri Govind Oil Mills, Cawnpore.
8. Marble Soap Works, Cawnpore.
9. Pearl Products Co., Cawnpore.
10. Cawnpore Soap Works, Cawnpore.
11. Western India Soap Works, Cawnpore.
12. Allahabad Soap Co., Ltd., Allahabad.
13. General Soap Works, Meerut.
14. Bannerji Brothers, Allahabad.
15. Bhargava Soap Works, Meerut.
16. King Soap Works, Meerut.
17. White Indian Soap Co., Meerut.
18. General Soap Factory, Meerut.
19. Dum Dumji and Co., Agra.
20. J. N. Khanna and Bros., Meerut.
21. L. Munna Lal Gupta and Co., Meerut.
22. Nar Singh Soap Factory, Meerut.
23. Norway Soap Co., Meerut.
24. Anand Soap Works, Agra.
25. Kanti Soap Works, Lucknow.
26. Bajpai Soap Co., Cawnpore.
27. Imperial Rama Soap Factory, Bareilly.

Bengal.

28. North-West Soap Factory, Kidderpore.
29. National Soap Factory, Entally.
30. Calcutta Soap Factory, Ballyganj.
31. Indian Soap Co., Entally.
32. Oriental Soap Factory, Calcutta.
33. Bengal Soap Factory, Cossipore.
34. Poineer Soap and Chemical Works, Calcutta.
35. Bengal Chemical Works, Calcutta.
36. Asoka and Sontosh Brothers, Dacca.
37. Boolbool Soap Factory, Dacca.
38. Buool Soaps, Bhowanipore.
39. Deplilatory Soap Factory, Calcutta.
40. East India Soap Factory, Calcutta.
41. Economic Soap Factory, Calcutta.
42. P. A. B. Punjab Soap Factory, Calcutta.
43. Satitva Mohan Das and Sons, Calcutta.
44. The Searmari Soap Factory, Bhagalpur.
45. Standard Soap Works, Calcutta.

Madras.

46. Government Kerala Soap Institute, Calicut.
47. Calicut Soap Works, Calicut.

Bombay.

48. The Lotus Soap Factory, Bombay.
49. The Dianua Soap Factory, Byculla.
50. The Industrial Chemical Works, Parel.
51. The Cleanall Oil Products Co., Bombay.
52. The Pioneer Maunfacturing Co., Ahmedabad.
53. The Silver Soap Manufacturing Co., Mazagaon.
54. The Imperial Soap Works, Poona.
55. The Daisy Soap and Steam Dyeing Works, Bombay.
56. The Diamond Soap Co., Girgaon.
57. The Indian Soap and Candle Works, Matunga.
58. The Godrej Soap Works, Byculla.

Baroda State.

59. The Indian Cotton Oil Co., Mavsari.
60. Rustomjee Hormusji Bana and Co., Navsari.
61. Western India Soap and Candle Works, Billimoria.
62. Sardesai's Soap and Chocolate Works, Billimoria.

Central Provinces.

63. The C. P. Briget Soap Factory, Nagpur.
64. The Nurbudda Soap Factory, Nagpur.
65. Laxmanrao Sakhardande Bros., Nagpur.
66. Bhikaji Atmaram Bros., Nagpur.
67. Sultana Soap Co., Dhamtari.
68. A. S. Abdul Gafoor Soap Factory, Nagpur.
69. Shri Laxmi Oil and Soap Works, Akola.
70. Shree Govind, Nagpur.

Punjab.

71. Enad Bros., Lahore.
72. Gunga Soap Factory, Ludhiana.
73. The Jolly Soap Factory, Rawalpindi.
74. The Popli Soap Works, Bhalwal.
75. Sher-i-Punjab Soap Co., Bujarkhan.
76. Visnu Soap Co., Amritsar.
77. F. C. College Soap Works, Lahore.

Mysore State.

78. Government Soap Factory, Bangalore.
79. Deen Soap Factory, Bangalore.
80. Hindu Soap Factory, Bangalore.

Travancore.

81. The Travancore Soap Works, Trivandrum.
82. Moideen Kunja, Haripad.

Rajputana.

83. Diamond Soap Works, Kishengarh.
84. Mehrajamal Soap Works, Co., Ajmer-Merwara.
85. Prabhakar Soap Works, Kishengarh.

Gwalior State.

86. Government Goal Soap Factory, Lashkar.
87. Gaikwar Oil and Chemical Co., Morar.
88. Gwalior Oil and Soap Factory, Gwalior.

Cochin State.

89. Floral Soap Works, Trichur.
90. Lochan Soap Works, Pudukkad.
91. Tata Oil Mills and Soap Works, Ernakulam.

Bhopal State.

92. Government Soap Factory, Bhopal.

North-West Frontier Province.

93. Isher Das Monalian Bahorian, Peshawar.
94. D. I. Khan's Nation Soap Works, Peshawar.

APPENDIX XXX.

List of Paint and Varnish Works in India.

Bihar and Orissa.

The Shanti Mining Concern, Bhubaneswar.

Bombay.

Ghagan Paint and Varnish Works, Bombay.
The Bijapur Mahalaxmi Co., Bijapur.
K. D. Rane and Co., Bombay.
Agarwal Paint Colour and Varnish Co., Bombay.
Arnak and Co., Bombay.
Eastern Paint Manufacturing Co., Bombay.

Bengal.

Calcutta Paint Colour and Varnish Works, Calcutta.
Murarka Paint and Varnish Works, Sodepur.
Jenson and Nicholson Paint Factory, Naipati.
Borman and Karain, Ltd., Entally.
Shalimar Paint and Varnish Works, Goabaria.
Hadfields Paint and Varnish Works, Howrah.
Hoyle Robson and Barnet, Calcutta.

Mysore.

The Mysore Pioneer Paint Works, Bangalore.
The White Lead Syndicate, Bangalore.

Central Provinces.

Olpherts Paints and Products, Ltd., Jabbulpore.
Ranade and Co., Warda.

APPENDIX XXXI.

Manufacturers of Boiled Linseed Oil in India.

Murarka Paint and Varnish Works, Calcutta.
Gourepur Co., Ltd., Naihati, Bengal.
Howarh Oil Mills, Ramkristopore, Calcutta.
Gahagan Paint and Varnish Co., Bombay.
Elephant Oil Mills, Bombay.
New Premier Oil Mills, Cawnpore.
Narain Das Lachman Das, Cawnpore.
Mahalaxmi Oil Mills, Bombay.

APPENDIX XXXII.

Manufacturers of Refined and Deodorised Vegetable Oils in India.

Krishna Flour and Oil Mills, Lyallpur, Punjab.
Tatas Oil Mill Co., Tatapuram Cochin State.
The Indian Cotton Oil Co., Navsari, Baroda.
The Burma Cotton Co., Myingyam, Burma.

APPENDIX XXXIII.

Manufacturers of Turkey Red Oil in India.

Pearl Products Co., Cawnpore.
Marble Soap Works, Cawnpore.

APPENDIX XXXIV.

Manufacturers of Oil Cloth in India.

Dharamsi Murarji Woollen Mills, Ambarnath, Bombay.
Bengal Waterproof Co., Calcutta.

APPENDIX XXXV.

Manufacturers of Hydrogenated Oil in India.

Krishna Flour Mills, Lyallpur, Punjab.
Forbes Forbes Campbell & Co., Bombay.

APPENDIX XXXVI.

Tables of efficiency and cost of crushing with various classes of oil mill plant as used in India.

The efficiency of methods used in the extraction of oil, varies considerably in the mills.

This is partly due to variation in the oil content of the seeds, and to the condition of the seeds at various times of the year.

There is also a great difference between the equipment of various mills, and throughout there is a lack of uniformity in both methods and the kind of plant used.

Variation in oil extraction, obtained by different kinds of plant.

(1) Bullock driven Ghannis and Chekkos.

Seeds.	Percentage of oil content of dry seed.	Percentage of possible average extraction of oil with modern plant.	Percentage of oil left in cake by bullock Ghannis.
Linseed	42—50	36—42	10—14·0
Til or Sesame	49—52	40—42	9·4—15·8
Groundnuts indicorticated..	37—44	33—40	12—15·8
Yellow Sarson	42—51	35—38	7·3—13·1
Safflower	30—33	19—22	10·0—14·5
Castor	42—56	38—40	7·6—14·0

These machines usually work from 2 to 3½ hours on each charge of 10 seers.

(2) Power driven Ghannis.

		By power.	Ghannis.
Linseed	42—50	36—42	10—14
Til or sesame	49—52	40—42	10—15
Toria	45—50	36—40	8—13
Yellow Sarson	42—51	35—38	8—13

The time occupied per charge of 10 seers is 1¾ hours in cold season and 1½ hours in the hot season.

(3) Hand Screw Presses.

Castor	42—56	38—40	6—10
Foots and Sludge from Tanks and Filter Presses ..	40—80	36—76	6—10

The hand screw press, gives efficient extraction, which is due to the pressure exerted upon small thin cakes, the rate of increasing the pressure, being below other types of presses. This efficiency is

to a large extent lost, owing to the high cost for press bagging, which lasts for one day only. The capacity of these presses is 10 to 15 maunds of seed per 10 hours.

The work is usually confined to the pressing of Castor seed, and sludge from Filter presses and settling tanks.

Anglo-American Presses.

Seeds.	Percentage of oil content of dry seed.	Percentage of possible average oil extraction.	Percentage of oil left in the cake.
Linseed	42—50	36—42	9—12
Til or Sesame	49—52	40—42	9—12
Groundnuts	37—44	33—40	8—12
Toria	45—50	36—40	10—12
Mahua	37—45	33—41	8—12
Castor	42—56	36—40	9—13

The efficiency of this type of plant, depends very largely upon the preliminary preparation of the seed, prior to being pressed, to the pressure given to the cake and rate of increasing pressure on the cake.

The output is also very materially affected by the type of press cloth used.

Cage and Box Presses.

Seeds.	Percentage of oil content in dry seed.	Percentage of possible average oil extraction.	Percentage of oil left in the cake.
Til or Sesame	49—52	37—43	9—12
Groundnuts	37—44	33—40	8—12
Mahua	37—45	34—42	8—12
Castor	42—56	37—42	9—12

There are not many mills in India equipped with these types of press, and where they are installed the work is seldom as rapid as it might be. The presses of the cage type, are efficient and easy to work, and give very high pressure on the cake. Throughout the industry there is a lack of ability to get good results from these types of press, which is due to faulty milling of the seed, and badly cooked meal. Too much time is lost in loading and unloading presses and the type of press cloth used also tends to reduce efficiency.

Oil Expellers.

Seed.	Percentage of oil content in dry seed.	Percentage of possible average oil extraction.	Percentage of oil left in the cake.
Castor	42—56	38—40	5·03—12
Linseed	42—50	36—42	8·69—12
Til or sesame	49—52	42—42	9·0—12·8
Groundnuts	37—44	33—40	7·0—10·8
Toria	45—50	36—40	10·0—13
Yellow Sarson	42—51	35—38	9·0—12
Mahua	37—45	34—42	6·9—12
Cotton seed decorticated	18—20	12—15	7·6—13

The Oil Expeller has become very popular in India. The machines are very efficient when properly worked. In India there is not sufficient care taken, which results in very heavy maintainance charges, and poor oil extraction. The seed is seldom properly prepared so as to get good results.

Practically no cotton seed is crushed in India except in Baroda and Upper Burma.

Cost of seed crushing with different plant.

The cost, per maund, of crushing seed varies very considerably. The preparation of one class of seed, for pressing differs from another class. The machines used in the preliminary operation differ, and the amount of power required also differs accordingly.

Comparison between one mill and another is difficult even when both mills are working on the same kind of seed, as the equipment of oil mills in India varies to an extraordinary extent.

It is not infrequent to find a mill crushing linseed and til seed in the same plant or to find rape seed being milled in plant meant for treating castor seed.

The amount of labour employed is usually excessive and in this respect there is considerable variation between one mill and another.

Mills equipped with Ghannis also vary considerably in their costs of production. The larger mills invariably have a foundry and engineering shop running in conjunction with the oil mill for the manufacture of the Ghannis, and for manufacturing the many spare parts required.

The smaller mills with Ghannis equipment purchase their Ghannis and spares from the former.

In making comparison with figures given below it is necessary to note that these are "net daily earnings" and do not include any figure for interest and depreciation or repair and up-keep of plant.

In the Cawnpore district the author of this note found that the small Teli was making a profit varying from 8 annas to Rs. 1-2-0 per day without calculating—

(1) interest on the money invested in bullock and plant,
(2) interest on loans for seed purchase,
(3) no payment for labour (except food for wife and child, which has not been included),
(4) no charge for depreciation of bullock and plant.

Bullock driven kolhus.

In 1922-23 the following figures relating to the above were published in the report on the Vegetable Oil Industry in the Punjab by Mr. John Brewis.

The net daily earnings of the Teli when crushing Sarson or Toria (mustard) were as under, when working 12 to 18 hours per day :—

	Rs. a. p.	Rs. a. p.	Per
Montgomery District	1 2 0	..	Per
Jullundur ,, ...	1 1 0	..	,
Sheikhupura ,, ...	1 4 0	..	,
Jhelum ,, ...	1 0 0	1 8 0	,
Sialkot ,, ...	1 8 0	1 12 0	,
Shahpore ,, ...	1 4 0	1 8 0	,
Gujranwala ,, ...	1 4 0	1 7 0	,
Lahore ,, ...	1 4 0	..	,
Kangra ,, ...	1 0 0	1 8 0	,
Lyallpore ,, ...	0 13 0	..	,
Ludhiana ,, ...	1 0 6	..	,

Power driven Kolhu Mills.

These mills vary in size from containing 10 pair of Ghannis, to 150 pair.

Such mills are usually steam driven.

In the United Provinces, there are several such mills driven by electric power.

Each Kolhu requires 1 to 1¼ H.P. to drive it, giving a maximum output of 3 maunds 16 seers of seed crushed, when working 24 hours.

Each pair of Kolhus costs Rs. 300, the annual repairs and replacement are approximately 50 per cent. of the original cost, owing to the very excessive wear on both wooden, and metal parts. In the cost of crushing, very few mills consider this very heavy item.

The cost of crushing as stated by various mills ranges between 7·5 annas and Rs. 1-4-0 per maund of seed crushed.

These figures are probably too low as the costs estimated are usually without interest on capital invested, and cost of repair and up-keep and renewal.

Hand Screw Presses.

In this work there is only small margin of profit, when the presses are used for seed crushing.

The largest known mill of this kind working with this class of equipment, is in the United Provinces. The mill contains some 32 presses.

The labour bill in this establishment appears to be very excessive. When the mill worked at its full capacity, there were some 478 persons employed to crush 130,536 maunds of seed, which is equal to an output of ·9 maunds of seed per head of labour per day.

When this mill worked only 20 presses, the hands employed fell to 373 and the output to 297 maunds per day, or ·79 maunds per person employed.

The fuel consumption was as under in crushing 65½ tons of seed—

	Tons.	cwt.	qr.
Coal ..	8	13	1
Coke ..	7	17	2
Wood	1	16	3
Total	18	7	2

which is equal to 1 maund fuel to 3·4 maund seed. The bill for unskilled labour, and fuel, represents a cost of 12 annas per maund of seed, without making any allowance for overhead charges, repairs, renewals, depreciation, bagging, etc.

In smaller equipments, when the work is undertaken by contract labour, to whom bagging, seed, and presses are supplied without charge, these persons, are paid a monthly sum around Rs. 14 per month provided that they give back an agreed amount of oil, and oil cake, against the daily seed issues. These persons usually work in parties of 3 or 4 men for 2 presses. In a large mill which contains other plant, there is one section equipped with 4 hand screw presses, where castor seed crushing is done.

The equipment consists of two hand driven decorticating rolls, one of which decorticates, while the other is used for milling the kernels after they have been separated from husk by a hand winnowing process.

The men working the 4 presses are daily served out with crushed kernels, gunny cloth and charcoal.

The following are the costs per maund when 4 presses are working :—

Total output per day	38 maunds seed.	
Husk separated from kernels 21·1 per cent. on original seed.	8 maunds.	
Total kernels crushed per day	30 do.	
Yield of oil 36·84 per cent. on original seed .. .	14 do.	
Yield of cake 40·1 per cent. on original seed .. .	15 do.	
Loss in weight 1·96 per cent.		
Labour Rs. 10 per day	=4·21 annas	per maund of seed.
Gunny bagging Rs. 6 per day	=2·5	ditto.
Charcoal fuel Rs. 12 per day	=5	ditto.
Total per maund of seed .	11·71 annas.	

Anglo-American Presses and Cage Presses.

The cost of crushing is stated by mill owners to be between 8 annas and 14 annas per maund of seed.

In such statements of cost it is doubtful whether the figures are to be relied upon. Observation over a number of years leads one to

believe that the figures are considerably higher, if definite calculations are made of such things as—

(1) Loss of oil.
(2) Up-keep of Press bagging.
(3) Depreciation.
(4) Interest.
(5) Repairs and Renewals.

The figures given above are possibly correct at 12 to 14 annas per maund of seed crushed. The figures below 12 annas are likely to include only cost of labour and fuel.

Oil Expellers.

It is difficult to ascertain any definite figures of cost from millers, as they are somewhat reluctant to disclose the actual costs even if they are available.

The wear and tear is excessive on these machines as used in India as is shown in Appendix XL.

In comparison with mills equipped with Hydraulic presses the bill for labour is considerably reduced.

In making any comparisons between the various types of plant it must be borne in mind that the Ghanni is for the most part used for crushing mustard seed only in Northern India.

Figures obtained from a large mill over a period of one month's work showed that the oil obtained was 30·3 per cent. of the mustard seed crushed.

Hydraulic presses are usually used when crushing such seeds as Castor, Mahua, Linseed, Groundnuts, Till seed and Copra.

In a mill equipped with Anglo-American presses it was found that the average oil obtained when pressing such seeds as Castor and Mahua was 39 per cent.

Comparisons made with cakes taken from mills equipped with Expellers and Presses show that the Indian mills appear to be able to get better results from the expellers than they can obtain by means of presses.

This difference is very largely due to the inefficiency of supervision and to inferior machinery for the preparation of the seed for pressing.

APPENDIX XXXVII.

Specification for Vegetable Oils.

GOVERNMENT OF INDIA.

INDIAN STORES DEPARTMENT.

Mustard (or Rape Oil).

1. The oil shall be genuine mustard (or rape) oil.
2. The oil shall comply with the following requirements:—

Specific gravity at 30°C/30°C	·903—·907
Saponification value	170—178
Iodine value	93—105
Acid value not more than	6·0

Castor Oil.

1. The oil shall be the genuine product of the castor seed.
2. The oil shall comply with the following requirements:—

Specific gravity, at 30°C/30°C	·952—·956
Saponification value	178—184
Iodine value	82—90
Acid value not more than	6·0

Coconut Oil.

1. The oil must be the genuine product of the coconut.
2. The oil shall comply with the following requirements:—

Specific gravity at 40°C.	·907—·911
Saponification value	248—290
Acid value not more than	6·0

Linseed Oil.

To be the genuine product of linseed free from turbidity sediment and undissolved water. On analysis to give results between the following limits:—

Specific gravity at 30°C/30°C	·922—·926
Saponification value	183—193
Iodine value not less than	180
Acid value not more than	4·0

Raw Linseed Oil for varnish making.

To satisfy the above specification and in addition must not deposit mucilage on heating to 300° C.

Refined Linseed Oil.

Acid value not more than 6·0.

In other respects to satisfy the specification for raw linseed oil.

In addition to be of a colour not deeper than that of the tandard and to be free from mineral acid.

Pale Boiled Linseed Oil.

To be prepared from genuine linseed oil and the necessary driers only.

To be of a colour not deeper than that of the standard.

On analysis to give results between the following limits:—

Specific gravity at 30°C/30°C	·927—·941
Saponification value	189—196
Acid value not more than	5·0

A glass plate coated with the oil will be suspended in a vertical position until the oil dries. The test will be carried out in the shade and in a free circulation of air.

The oil should dry within 16 hours and give a firm elastic film free from stickiness.

Double boiled linseed oil.

To be prepared from genuine linseed oil and the necessary driers only. On analysis to give results between the following limits:—

Specific gravity at 30°C/30°C	·929—·941
Saponification value	189—196
Acid value not more than	6·0

When exposed under the same condition as stated in specification for pale boiled linseed oil the oil should dry within 8 hours and give a firm elastic film free from stickiness.

APPENDIX XXXVIII.

Rates and wages paid in the Oil Seed Crushing Industry.

Class of workers.	England.			India.	
	Liverpool.	Bristol.	Hull.	Cawnpore.	Bombay.
	The wage per week has been converted per month and has been converted into Rupees.			Per month.	Per month.
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a.p.	Rs. a. p.
Engineers	180—300	180—300	180—300	100—200	150 with free quarters.
Mechanics	..	..	..	45—100	..
Fitters	174	174	174	20—60	60—97
Pressman	163 8 0	148 8 0	148 8 0	25—50	40
Roller man	163 8 0	148 8 0	148 8 0	17—30	30
Fitter man	156 0 0	148 0 0	148 0 0	18—22	30
Greasers	156 0 0	148 0 0	148 0 0	16—18	28
Cake baggers	142 8 0	148 8 0	148 8 0	16—22 or by contract.	
Cleaners	142 8 0	148 8 0	148 8 0	15	26
Labourers	142 8 0	148 8 0	148 8 0	12—15	..
Boys under 16 years ..	61 8 0	61 8 0	61 8 0	..	..
Ditto 17 „ ..	70 8 0	70 8 0	70 8 0	..	..
Ditto 18 „ ..	87—99	87—99	87—99	..	..
Ditto 19 „ ..	118 8 0	118 8 0	118 8 0	..	..
Ditto 20 „ ..	132 0 0	132 0 0	132 0 0	..	..

APPENDIX XXXIX.

Recent Publications relating to the Vegetable Oil industry in India.

Groundnuts in the Bombay Deccan, 1911, by G. I. Kelkar, Assistant Professor of Agriculture, Poona.

A few Notes on Indian Groundnuts, by E. Lieberherr, Manager, Volkart Bros., Bombay.

Report on the Vegetable Oil Seeds and Associated Industry of the Punjab, by John Brewis. Published for Department of Industries, Punjab.

The Oil Seed Crushing Industry of United Provinces, 1924-25, by J. A. H. Duke. Published by Government Press, Allahabad.

Report on the Indian Vegetable Oil Industry, by Dr. P. E. Lander, M.A., D.Sc., A.I.C., Agricultural Chemist to Government of Punjab.

Indian Trade Enquiry Report on Oil Seeds. Imperial Institute, S. Kensington.

The Oil Industry in India, by R. M. Vakil.

Prospects of Oil Industry in India, by Banesvar Das.

Oil Pressing Industry of the Bombay Presidency, by Y. G. Pandit.

The Journal of the Central Bureau for Animal Husbandry and Dairy in India.

(*a*) Vol. III, Part III, October 1929.

(*b*) Vol. IV, Part I, April 1930.

The Effect of some Oil Cakes on Milk Secretion.

Tung Oil—Particularly referring to the possibilities of production within the Empire with a bibliography of the literature, by L. A. Jordan, D.Sc., A.R.C.Sc., F.I.C., D.I.C.

Memoirs of the Department of Agriculture in India. Some Digestibility Trials on Indian Feeding Stuffs—Part V. American and Indian Cotton Seeds, by P. E. Lander, M.A., D.Sc., A.I.C., Agricultural Chemist to Government, Punjab.

The Madras Agricultural Journal, Vol. XVII, No. 7, Wealth from Waste, by Dr. Gilbert J. Fowler, D.Sc., F.I.C.

Recent Researches on the Bio-Chemistry of the Nitrogen Cycle, by Dr. Gilbert J. Fowler, D.Sc., F.I.C.

The Vegetable Oil Industry in the Bombay Presidency, by A. F. Yuill.

Digestibility Trials on Indian Feeding Stuffs.

Feeding Trials on American and Indian Cotton Seed by P. E. Lander, M.A., D.Sc., A.I.C., and Pandit Lan Chand Dharmani, L.Ag., B.Sc. (Agri.).

Scientific Feeding of Farm Animals—Bulletin No. 24,. Department of Agriculture, Central Provinces, by R. G. Allen.

Tung Oil, by L. A. Jordan, D.SC., A.R.C.SC., F.L.C., D.I.C. Published by the Research Association of British Paint, Colour and Varnish manufactures.

Questions and Answers on Tung Oil Production in America, by N. A. Gardner.

Report on the Vegetable Oil Industry of Hyderabad State, by A. F. Yuill.

The Problem of India's Ghi Supply, by J. A. Hare Duke.

The Centrifugal Machine and its use in Oil Crushing Industry, by J. A. Hare Duke.

Some Problems of the Seeds Trade and Industry, by Magan Lal H. Gandhi, M.A., LL.B. (Prepared for the Seeds Trade Association, Bombay).

The Oil Milling Industry, by L. S. Pinto, M.SC., A.M.I., MECH.E. Bulletin No. 29, Department of Industries, Madras.

APPENDIX XL.

Estimate of loss experienced when a mill fitted with expellers stops to change worn out parts.

The seed crushed by an expeller working at normal speed is approximately 5 maunds per hour.

Each time that a discharge worm has to be refitted during working hours, it frequently occupies a working day of 10 hours. Thus the profit on seed crushing is lost, as well as the additional loss caused by expenditure on unproductive labour and overhead charges.

The loss is accentuated in many mills which make their own spare parts owing to their more rapid deterioration as is shown by the following :—

Annual cost of changing imported spare parts.

	Rs. a. p.
Loss of profit on 100 maunds of seed at annas 4 per maund ..	25 0 0
Unproductive wages of 20 men at annas 8 per day of 10 hours ..	20 0 0
Cost of two imported discharge worm	100 0 0
	145 0 0

N. B.—The costs of spare parts are now considerably below costs given.

The country made discharge worms are stated to cost Rs. 20 each and are found to wear out after 2 weeks.

	Rs. a. p.
Loss of profit on 1,200 maunds of seed 4 annas per maund ..	300 0 0
Unproductive wages of 20 men at annas 8 per day of 10 hours ..	240 0 0
Cost of 24 discharge worms at Rs. 20	480 0 0
	1,020 0 0
Unnecessary loss occasioned by the use of Country made parts and by inefficient seed cleaning	875 0 0

Statement of Total Expenditure on replacement of worn parts for an oil expeller working at Harcourt Butler Technological Institute.

The expeller was crushing cleaned seed and included such seeds as—

Linseed, Til seed, Castor seed, Mustard, Mahua and Cotton seed.

The amount of seed crushed was approximately 27,700 maunds.

The number of hours worked were 5,543.

Name of part replaced.	Origin.	Cost in rupees.
1 Cone point	Imported	88
2 Pressing worms	Do.	150
2 Knife bars	Do.	29
1 Set cage bars	Do.	480
Total cost ..		747

The above cost is equal to 5·1 pies per maund of seed crushed.

It has already been stated that the wear and tear on plant in Indian Oil Mills is abnormally heavy, consequently in addition to the above parts it is not uncommon to find that it is necessary to replace other parts such as spacing collars, bearings, spur and pinion driving wheels, and quill or feed worms.

These parts are now made in India, and owing to bad finish and inferior material which lacks the necessary hardness of surface, they are unable to stand up to the work and which in consequence wear out rapidly.

Enquiry, in some of the more important mills, equipped with a number of expellers, shows that the life of a new set of country made cage bars is only 6 to 8 weeks.

After 5 to 6 weeks work they give poor extraction and allow a heavy escape of meal in semi-pressed condition.

At this stage they are changed and are machined after which they may work for a further 2 weeks. The cost of a set of country made cage bars ranges between Rs. 250 and Rs. 400.

The figures of cost of replacing worn parts as stated by various millers lies between Rs. 2,000 per expeller when working 10 hours per day and Rs. 5,000 when working 24 hours daily.

The latter figure is actually more than the cost of a new expeller.

The following figures give a comparison of replacement costs between a mill using country made parts and an expeller equipped with makers' imported parts, the latter machine working on well cleaned seed. The figures are for 300 days of 24 hours, crushing 36,000 maunds of seed.

Expeller fitted with country-made parts.		Expeller equipped with maker's imported parts.	
Names of parts.	Cost.	Names of parts.	Cost.
	Rs.		Rs.
3 Cone points	30	2 Cone points 88 ..	176
24 Pressing worms	480	3-8 Pressing worms at Rs. 25-8-0	98
8½ Sets of cage bars ..	2,125	1¼ Sets cage bars at Rs. 375 ..	469
3 Pairs of knife bars ..	87	1 Pair knife bars at Rs. 22 ..	22
Total cost ..	2,722	Total cost ..	765
Cost per maund of seed crushed 1 anna 2·51 pies.		Cost per maund of seed crushed 3·74 pies.	
After spare parts required include spacing collars, feed worms, bearings, spur wheels, etc.		Other spare parts required.	Nil

APPENDIX XLI.

The Industrial and Commercial possibilities of Castor Seed Crushing in India, by J. A. HARE DUKE.

There do not appear to be definite figures relating to the quantity of castor seed which is grown in India, this fact is perhaps due to the custom of growing castor seed as an edging to fields of the main crops. Howard gives the total crop in 1924-25 at 114,000 tons.

There are however figures relating to the exports of castor seed which amounted to 121,436 tons in 1928-29. In addition there are considerable quantities of castor seed crushed in Hyderabad (Deccan), Madras, United Provinces, Bihar, Bombay and Bengal, which supply the Indian market for oil, as well as supplying an overseas market with some 2,200 tons of castor oil.

The largest consumers of castor oil in India are the Railways.

Twenty years ago, Indian Railways consumed very large quantities of this oil both as lubricant and a burning oil. The ten large Railways consumed annually a quantity which must have approached 10,000 tons, while the amount required for some 35 Railways owned by Indian States, probably amounted to 6,000 tons which represented the crushing of some 45,000 tons of castor seed.

From this it may be assumed that the production of castor seed in India reached a figure around 200,000 tons.

In recent years the consumption of castor oil in India has been very seriously reduced, this may be attributed to two chief causes.

1. The oil mills of India failed to produce castor oil of a sufficiently good quality, and frequently they failed to deliver oil at the rate which was required by the Railways, with the result that they lost a very considerable portion of the business.

It was essential for the Railways to have regular supplies, which caused the Bombay Baroda and Central India Railway, the East Indian Railway and the Bengal and North-Western Railway to erect their own oil mills.

2. The Mineral Oil Companies began to produce suitable high class lubricants, which, by means of very up to date sales organisation, gradually displaced castor oil entirely from many of the Indian Railways.

These mineral oil lubricants are sold at prices at which it is impossible to produce castor oil.

The question, as to whether, low priced mineral oil lubricants are in fact cheaper than good quality castor oil for Railways in India, is one which requires to be most carefully investigated.

Engineers in charge of Railway locomotive and repair shops, who have had experience both of the days when castor oil alone was used in engine bearings, and of the present days when mineral oil lubricants have come into use, are in a position to give useful information on this subject. Some consider that they experienced far less breakdowns through lubrication trouble when castor oil alone was used, and that since its use has been given up, the cost of replacing or repairing bearings has gone up considerably.

Mineral oils have enabled store departments to show a great saving on the cost of lubricants purchased, but it is possible that if the other side of the question were examined by experts, it would be found that what has been saved in cost of oil, has been considerably exceeded by the losses caused by engines under repair, workshop wages for repair work, and cost of material for new bearings, etc.

There is a further economic aspect to be considered, namely, the supply of organic manures for crop production, which in turn produces a vast income for Indian Railways. This income might be further augmented if such organic manure as castor cake were available in larger quantities, to enable the Indian agriculturalist to produce larger crops.

The export of castor seed from India in 1928-29 was 121,436 tons leaving possibly 80,000 tons to be utilised as under :—

Seed for sowing	..	8,000 tons.
Seed for crushing	..	72,000 tons.

It may, therefore, be estimated that the present consumption of castor oil in India is around 23,000 tons. Exports are 2,000 tons.

This oil is used for the following purposes :—

(1) A quantity is still used by some railways as a lubricant.
(2) As a lubricant in industrial concerns.
(3) For the manufacture of certain classes of soap.
(4) For burning purposes.
(5) For the manufacture of Turkey Red oil.
(6) For medicinal use.
(7) Export (2,000 tons).

The oil produced in India at present is for the most part of very inferior quality, and does not approach the quality of the oil produced in other countries. This serious defect in quality may be attributed to the following causes :—

(1) The quality of the oil contained in the seed is often irreparably damaged, before the seed is out of the hands of the grower. This requires attention if the castor oil business is to revive.

(2) The equipment of the oil mills in India is quite unsuitable for the production of castor oil, only one or two mills out of some 600 have the correct type of plant for obtaining the oil from the seed.

Possibly five or six mills are equipped with plant suitable for treating the oil, after it has been obtained from the seed.

(3) Insufficient care is given to cleanliness in oil mills, which is fatal in the production of good quality castor oil, and the seed is often stored under absurd conditions.

(4) A large quantity of the castor seed crushed in India is done by persons whose knowledge of oil technology is practically nil. The actual producers of the oil, and those who are responsible for all processes up to the time the oil is ready for sale, are for the most part of the illiterate coolie class.

The present methods require to be scrapped almost entirely. New methods and plant must be introduced, if the trade is to be recovered.

If such improvements can be introduced, there is a reasonable chance for India's trade in castor oil to be put upon a prosperous footing.

During recent years, the increase of motor transport, and the development in India of aviation, have made new openings for the use of Castor oil, and it would not be a difficult matter, if the problem is seriously tackled, for India to produce all the castor oil which these new industries will require, as well as putting her in a position to supply overseas buyers.

To effect this, capital must be available for new plant, the correct type of plant must be selected, and there must be employed oil chemists and technologists, who understand the necessary conditions required for the production of high class castor oils. At the same time it must be impressed upon the agriculturalist the necessity for using castor cake as a fertiliser, in increased quantities, for unless there is a very much increased demand over and above that which at present exists, it will not be possible to produce the oil at competition prices, or even at prices which would make the operation profitable.

The cake, from the industry as it stands at present, finds a market with considerable difficulty. It is perhaps largely due to this matter that mineral oils have made such headway, and have ousted castor oil from its former important position.

There appears to be no export demand for castor cake. The total export for 1928-29 was 1,212 tons. It is, therefore, essential that means be found to enable the agriculturalist to finance and use an increasing quantity of this very valuable fertiliser.

Unless there is this new demand for castor cake, it will not be possible to alter present conditions as it would not be profitable for those engaged in the trade to make the expenditure for new plant until the time has come that they are assured of markets for both their oil and oil cake.